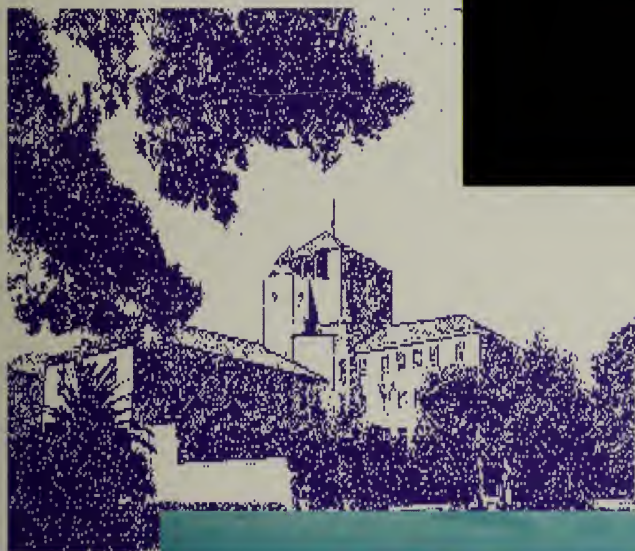


NAVAL POSTGRADUATE SCHOOL

Academic Year 1995



OVERVIEW

The School

The Naval Postgraduate School is an academic institution whose emphasis is on study and research programs relevant to the Navy's interests, as well as to the interests of other arms of the Department of Defense. The programs are designed to accommodate the unique requirements of the military.

The Campus

Located in Monterey, California, on the Pacific Ocean 120 miles south of San Francisco, the Naval Postgraduate School campus covers 627 acres of land. The site, which has been home to NPS since 1947, houses state-of-the-art laboratories, numerous academic buildings, a library, government housing and impressive recreational facilities.

The Students

Nearly 2,000 students attend the Naval Postgraduate School. The student body consists of officers from the five U.S. uniformed services, officers from approximately 25 allied countries and a small number of civilian employees. Selection of officers for fully funded graduate education is based upon outstanding professional performance as an officer, promotion potential and a strong academic background.

The Faculty

The faculty, the majority of whom are civilians, are drawn from a broad diversity of educational institutions and represent a prestigious collection of scholars. Faculty/student interaction is high. Every class is taught directly by a faculty member— over 99% of whom have a Ph.D.

The Degrees

The Naval Postgraduate School offers classes leading to advanced degrees in a variety of technical fields.

MASTER OF ARTS DEGREE: National Security Affairs

MASTER OF SCIENCE DEGREE: Aeronautical Engineering, Applied Mathematics, Astronautical Engineering, Computer Science, Electrical Engineering, Engineering Acoustics, Engineering Science, Information Technology, Management, Mathematics, Mechanical Engineering, Meteorology, Meteorology and Physical Oceanography, National Security Affairs, Operations Research, Physical Oceanography, Physics, Systems Technology, Systems Engineering.

ENGINEER DEGREE: Aeronautical Engineer, Aeronautical and Astronautical Engineer, Electrical Engineer, Mechanical Engineer.

DOCTOR OF PHILOSOPHY: Aeronautical Engineering, Computer Science, Electrical and Computer Engineering, Engineering Acoustics, Mathematics, Mechanical Engineering, Meteorology, Operations Research, Physical Oceanography, Physics, Systems Management

DOCTOR OF ENGINEERING: Aeronautical Engineering, Electrical and Computer Engineering, Mechanical Engineering.

For more information on admissions, or for a catalog, contact:

Director of Admissions
Code 62, Naval Postgraduate School
589 Dyer Road, Room 103C
Monterey, CA 93943-5100
Telephone: (408) 656-3093 / DSN 878-3093



NAVAL POSTGRADUATE SCHOOL

MONTEREY, CALIFORNIA 93943-5134
408/656-3093 DSN 878-3093

TABLE OF CONTENTS

| | |
|--|-----------|
| Introduction | 6 |
| Letter from the Chief of Naval Operations | 6 |
| The School and Its Mission | 7 |
| Accreditation | 7 |
| Degrees Conferred | 7-8 |
| Facilities | 9-10 |
| School Structure and Organization | 11 |
| Graduate Education Review Board | 11 |
| Board of Advisors | 11 |
| Administration | 12 |
| Administrative Staff | 12 |
| Academic Departments and Groups | 13 |
| Curricular Offices | 13 |
| International Programs Office | 14 |
| Curricula Summary | 15-18 |
| Faculty Organizations | 18 |
| Student Council | 18 |
| Admissions | 19 |
| Selection Procedures | 19 |
| Naval Officers | 19 |
| Other U.S. Military Officers | 19 |
| International Military Officers | 19 |
| Civilian Employees of U.S. Government | 19-20 |
| Academic Profile Codes | 20-21 |
| General Information | 22 |
| Course Codes | 22 |
| Grading | 22-23 |
| Quality Point Rating (QPR) | 23 |
| Academic Counseling | 23 |
| Course Registration and Credit | 24 |
| Overload | 24 |
| Repetition of Courses | 24 |
| Medical Absence | 24 |
| Credit by Examination | 24 |
| Validation | 24 |
| Transfer of Credits | 24-25 |
| Dual Degree Programs | 25 |
| Educational Skill Requirements | 25-26 |
| Curricula Conducted At Other Universities | 27 |
| Curricular Offices and Programs | 29 |
| Aerospace Engineering Programs | 29-37 |
| Meteorology and Oceanography (METOC) Programs | 38-47 |
| Combat Systems Programs | 48-52 |
| Electronics and Computer Programs | 53-61 |
| Joint Command, Control and Communications (C3) | 62-65 |
| National Security and Intelligence Programs | 66-90 |
| Naval Engineering Programs | 91-96 |

TABLE OF CONTENTS (continued)

Operations Research Programs 97-106
Systems Management Programs 107-145
Undersea Warfare, Space Systems and Electronic Warfare Programs 146-160

Academic Departments and Course Descriptions..... 161

Aeronautics and Astronautics Department 161-176
Aviation Safety Programs 177-179
Command, Control and Communications (C3)
 Academic Group 180-182
Computer Science Department 183-194
Electrical and Computer Engineering Department 195-216
Electronic Warfare Academic Group 217-218
Engineering Acoustics Academic Committee 219
Mathematics Department 220-231
Mechanical Engineering Department 232-243
Meteorology Department 244-252
National Security Affairs Department 241-254
Oceanography Department 268-275
Operations Research Department 276-291
Physics Department 292-309
Space Systems Academic Group 310-311
Systems Management Department 312-332
Undersea Warfare Academic Group 333-334

Defense Resources Management Institute 335-338

Appendices 339

A. Distinguished Alumni 339
B. Awards for Graduates 341-344
C. Awards for Faculty 345

Index..... 346-352

Academic Calendar 353-354

INTRODUCTION



J. M. Boorda
Admiral, U.S. Navy
Chief of Naval Operations

CNO GRADUATE EDUCATION POLICY

"I reaffirm the investment in graduate education of selected officers to be a strategic requirement for Navy. With today's technological, managerial, political and economic complexities, educating officers in specific subspecialties greatly increases operational readiness and, as a corollary benefit, develops the intellectual diversity and capacity that enhances the total professional performance of our officer corps. Our investment in graduate education must be pursued as a priority even in the face of competing demands and declining resources."

"The Naval Postgraduate School (NPS) will remain Navy's primary source of fully-funded graduate education. NPS will remain committed to the development of curricula that meet the highest standards of excellence and the unique professional needs of the Navy and the Department of Defense (DoD)..."

J. M. Boorda
Admiral, U.S. Navy

"Leadership and learning are indispensable to each other."

-- President John F. Kennedy

THE SCHOOL

To meet its educational requirements, the Navy has developed a unique academic institution at the Naval Postgraduate School (NPS) through the use of specially tailored academic programs, a distinctive organization tying academic disciplines to naval applications.

The student body consists of U.S. officers from all branches of the uniformed services, civilian employees of the federal government and military officers and government civilian employees of other countries. Selection of officers for fully funded graduate education is based upon outstanding professional performance as an officer, promotion potential and a strong academic background. Students receive graduate degrees as a result of successful completion of study programs designed primarily to prepare them for future career assignments; however, degrees are awarded on the basis of the same academic standards that prevail at other accredited institutions.

NPS is an academic institution whose emphasis is on study and research programs that are relevant to the Navy's interests, as well as the interests of other arms of the Department of Defense (DoD). The programs are designed to accommodate the unique requirements of the military.

THE MISSION

The Naval Postgraduate School was established to serve the advanced educational needs of the Navy. The broad responsibility of the school is reflected in its stated mission:

The mission of the Naval Postgraduate School is to provide advanced professional studies at the graduate level for military officers and defense officials from all services and other nations. The school's focus is to increase the combat effectiveness of the armed forces of the United States by providing quality education which supports the unique needs of the defense establishment.

An expansion upon this mission which has been excerpted from SECNAV INSTRUCTION 1524.2A, March 27, 1989:

The Naval Postgraduate School exists for the sole purpose of increasing the combat effectiveness of the Navy and Marine Corps. It accomplishes this by providing post-baccalaureate degree and nondegree programs in a variety of subspecialty areas not available through other educational institutions. NPS also supports the Department of Navy through the continuing programs of naval and maritime research and through the maintenance of an expert faculty capable of working in, or as advisors to, operational commands, laboratories, systems commands, and headquarters activities of the Navy and Marine Corps.

To fulfill its mission, the Naval Postgraduate School strives to sustain excellence in the quality of its instructional programs, to be responsive to technological change and innovation in the Navy, and to prepare officers to introduce and utilize future technologies.

ACCREDITATION

The Naval Postgraduate School is accredited by the Accrediting Commission for Senior Colleges and Universities of the Western Association of Schools and Colleges. Engineering curricula accredited by the Accrediting Board for Engineering and Technology (ABET) are Aeronautical, Electrical and Mechanical. The Systems Management Curricula are accredited by the National Association of Schools of Public Affairs and Administration.

DEGREES CONFERRED

Although the curricula are tailored to address Navy requirements, they are developed within the framework of classical academic degrees, meeting the highest academic standards. Each curriculum leads to a master's degree; however, additional study can lead to either an engineer's degree or the doctor's degree.

DEGREES

MASTER OF ARTS DEGREES

National Security Affairs

MASTER OF SCIENCE DEGREES

Aeronautical Engineering
Applied Mathematics
Applied Science
Astronautical Engineering
Computer Science
Electrical Engineering
Engineering Acoustics
Engineering Science
Information Technology Management
Management
Mechanical Engineering
Meteorology
Meteorology and Physical Oceanography
National Security Affairs
Operations Research
Physical Oceanography
Physics
Systems Technology
Systems Engineering

ENGINEER DEGREES

(Typically requires one year of study beyond the Master's Degree)

Aeronautical Engineer
Aeronautical and Astronautical Engineer
Electrical Engineer
Mechanical Engineer

DOCTOR'S DEGREES

Doctor of Philosophy:
Aeronautical Engineering
Computer Science
Electrical and Computer Engineering
Engineering Acoustics
Applied Mathematics
Mechanical Engineering
Meteorology
Operations Research
Physical Oceanography
Physics
Systems Management

Doctor of Engineering:
Aeronautical Engineering
Electrical and Computer Engineering
Mechanical Engineering

DUDLEY KNOX LIBRARY

The Dudley Knox Library is a university library and as such it is expected to meet standards established by the School's principal accrediting body, the Western Association of Schools and Colleges (WASC). It is, furthermore, unique within the community of academic libraries in that it is dedicated both to supporting research and graduate-level education and to providing for the special requirements of the Naval Postgraduate School. For example, in addition to its open- literature collections in the disciplines of science, engineering, national security affairs, and administrative sciences, it administers a powerful collection of classified (Secret/Confidential) research reports. The Library opened a Secure Word Processing Facility in the first quarter of 1994 which enables students and other members of the campus community to prepare theses and other reports of research which draw upon its collections of classified materials. Presently, the Library's holdings number approximately 400,000 bibliographic volumes in hard copy, 500,000 volumes in microform, and 1200 journal subscriptions. A staff of 38 librarians and library support personnel identify and process materials for the collection and assist members of the campus community and the public to find information resources useful for their work.

The Library has just completed an expansion project, nearly doubling the usable space which now totals approximately 100,000 sq. ft. The Library contains photocopy facilities, individual study carrels, and group study rooms and provides reference, on-line searching, circulation, and telephone paging services. The Christopher Buckley, Jr. Collection of books on naval and maritime history includes both fiction and nonfiction. The Library is a selective depository for information distributed by the United States Government Printing Office.

The Library is organized into divisions responsible for acquiring and processing research and instructional materials and customer support in the use of these materials. The technical Services division purchases, classifies, and catalogs the materials and enters them into the Library's on-line catalog. The Reader Services Division provides reference, on-line searching, and circulation services from the Library's open-literature collections. The Research Reports Division provides circulation, reference, and selective dissemination of information services from the classified and confidential report literature from print, optical disk, and on-line resources. The Library is a member of the Monterey Bay Area Cooperative Library System which provides expedited interlibrary loan among its member libraries.

The Library's automated library management systems, BOSUN and STILAS, provide on-line catalog access to library materials in the open- literature collections and in the Research Reports Division, respectively, as well as automated circulation.

The Library Council is an advisory body with faculty members drawn from each academic department and academic group, as well as a student representative from OSAC. Council members serve as departmental liaisons, advising the library on priorities for the Library's collections and information services, as well as book and serial procurement.

CAMPUS COMPUTING

The many computer-based and professional support services provided by the Computer Center are available free to all faculty, staff and students of the School in connection with instructional, research or administrative activities. Round-the-clock operational support is provided on two major multi-access systems, an AMDAHL 5995-700A running IBM's VM/XA and MVS/ESA operating systems, and a CRAY Y-MP/EL98 Supercomputer running UNICOS.

The AMDAHL has 2 processors sharing 384 MB processor storage, 1 GB of expanded storage for paging space and 40 I/O channels. Auxiliary devices include IBM 3380 disks (models XE to XK), IBM 3480 Cartridge Tape Drives (18-track), IBM 3420-8 Tape Drives (9-

track, 6250 bpi) and an IBM 3800-3 high-speed page printer. The most direct mode of user access is via 600 IBM 327X terminals, or PC-compatibles, distributed in public clusters and private offices throughout the academic buildings and hard-wired to the Center in Ingersoll Hall. In addition, full micro-to-mainframe dial-up capability is supported at speeds up to 9600 bps.

The AMDAHL mainframe supports a wide range of applications under IBM's two operating systems: VM/XA (Virtual Machine/Extended Addressing), for interactive computing, and MVS/ESA (Multiple Virtual Systems) for batch-production and transaction processing for applications such as the Knox Library's On-line Catalog. The extensive programming facilities include FORTRAN, ADA, C, COBOL, PL/1, APL2, PASCAL and BASIC.

The CRAY mini-supercomputer has 8 processors sharing 2 GB main storage and 50 GB disk storage. It is used for numerically-intensive, research computing in science and engineering. The AMDAHL and the CRAY systems share a StorageTek Corp.'s Automated Cartridge System (with capacity for 12,000 tape cartridges at 400 MB each) for system-managed mass storage, backup and archiving of data. The CRAY is directly connected by FDDI link to the Center's Scientific Visualization Laboratory in Ingersoll Hall, Room 148. This lab contains a variety of high-performance graphics work-stations including a Silicon Graphics' 380 VGX system with 8 processors for sophisticated graphics rendering, computer animation and generation of professional-quality video tapes. This is a state-of-the-art facility for visualization of the results of complex computer simulations and models run on the School's computers and workstations.

All of these, and other, server facilities are accessible on the campus backbone network which presently supports 10 Mbps Ethernet over fiber-optic cable. In early 1994 the bandwidth was improved to at least 100 Mbps. The Center also maintains several laboratories and open clusters of workstations distributed in the academic buildings. These include six Learning Resource Centers - classrooms equipped with PCs, Macs and Unix workstations. The open clusters contain SUN SPARC10 workstations with full network access and IBM 327X terminals directly connected to the AMDAHL mainframe. Some 270 workstations are available in these facilities for use by students, faculty and staff.

Wide-area network support includes the INTERNET (at T1, soon to be T3, speed), MILNET (at 56 Kbps) and BITNET/CREN. The Center's professional staff conducts short courses, and provides consulting help in systems and applications programming, and on computer problem-solving tools and techniques. They also engage in a research and development program directed primarily toward continuously improving the campus computing environment and the exploitation of new and emerging technologies in support of academic computing.

Supplementing the Center's facilities are the many departmental classrooms and laboratories equipped with microcomputers and/or workstations which support their subspecialized educational or research needs. Most of these systems are on local-area networks which are connected to the campus backbone.

NAVAL POSTGRADUATE SCHOOL FOUNDATION

The Foundation is a non-profit corporation whose purpose is to provide support from private sources to the Naval Postgraduate School. Towards this end, the Foundation solicits, receives and administers tax-exempt charitable contributions. These gifts are expended in behalf of programs and activities that are deemed important by the School Superintendent but are outside government funding limits.

Since its founding in December, 1970, ongoing Foundation support has enabled it to have progressively increasing impact on School operations. Currently, it administers more than a dozen major projects serving to promote excellence in academic accomplishments and research, and enhancing the academic and support facilities of the School. Individuals wishing to participate in the work of the Foundation may obtain further information by writing to the Naval Postgraduate School Foundation, P.O. Box 8626, Monterey, CA, 93943.

NAVAL POSTGRADUATE SCHOOL ALUMNI ASSOCIATION

The NPS Alumni Association was formed at the recommendation of the Superintendent after responses to a January 1991 survey of graduates showed strong support. The Naval Postgraduate School Foundation agreed to sponsor the Association and the June 1991 graduates were the first to be given the opportunity to enroll as members of the new NPS Alumni Association.

The goals of the Association are to provide a vehicle for sharing ideas among the alumni and to assist in communications from the school to alumni. The NPS Alumni Association expects to expand its activities to include those of the traditional university alumni association. These activities will evolve to meet the needs and desires of its steadily growing membership. The Association publishes a quarterly newsletter which is mailed to all members, and sponsors the publication of a periodic alumni directory.

The Alumni Association Office is located in Herrmann Hall on the school campus. To contact the Association, call (408) 656-4011 or write to: NPS Alumni Association, P.O. Box 8626, NPS, Monterey, California 93943. You can fax to (408) 656-3757, or e-mail to alumni@nps.navy.mil.

SCHOOL STRUCTURE AND ORGANIZATION

The Naval Postgraduate School was established and is funded by the Congress of the United States. It is administered as an activity within the Department of the Navy. The institution's governance and administration follow norms for civilian higher education, adapted appropriately for the Navy's specialized needs.

GRADUATE EDUCATION REVIEW BOARD

A Graduate Education Review Board, chaired by the Chief of Naval Operations and including the Vice Chief of Naval Operations, the Deputy Chief of Naval Operations (Manpower, Personnel and Training, OP-01), the Superintendent, Naval Postgraduate School and a representative from the Naval Systems Command (on a rotating basis) meets annually to provide policy guidance and direction for the Navy's graduate education program. The Board reviews the adequacy and stability of resources and student input. Prior to this meeting, a separate Graduate Education Review Group, chaired by the Vice Chief of Naval Operations, meets to review graduate education issues and identify matters of potential interest to the Graduate Education Review Board. The Graduate Education Review Group membership includes the principal warfare sponsors, principal subspecialty primary consultants and the Superintendent, Naval Postgraduate School.

BOARD OF ADVISORS

The Board of Advisors is composed of distinguished professionals, consisting of highly qualified civilian educators, prominent citizens from business, the professions and other vocations, and active and retired military officers. The purpose of the Board is to assist the Superintendent on strategic matters of the Navy's Graduate Education Programs and advise the Secretary of the Navy of their needs. In fulfilling this objective, the Board assesses the effectiveness with which the Naval Postgraduate School is accomplishing its mission and evaluates its future plans. Board members are appointed for terms of two years by the Secretary of the Navy upon the recommendation of the Superintendent. Each appointment is renewable once for a second period of two years.

The Board meets annually at the Naval Postgraduate School and submits a report of its recommendations to the Secretary of the Navy via the Superintendent. Board members also serve on departmental academic review committees during the year and assist in other matters as requested by the Superintendent or the Secretary of the Navy.

ADMINISTRATION

The Superintendent of the Postgraduate School is a flag officer of the line of the Navy. His principal assistant is the Provost/Academic Dean, who is ranking member of the civilian faculty.

SUPERINTENDENT

Thomas A. Mercer
Rear Admiral, U.S. Navy

PROVOST & ACADEMIC DEAN

Harrison Shull, Ph.D.

The Superintendent has command responsibility for accomplishment of the school's mission. The Provost/Academic Dean is the chief educational officer and is responsible to the Superintendent for all academic matters. He is appointed by the Secretary of the Navy upon the recommendation of a council of NPS senior personnel, chaired by the Superintendent.

In addition to serving as the institution's president, the Superintendent is the academic coordinator for all graduate education programs in the Navy. He administers fully funded graduate educational programs at the Naval Postgraduate School, other service graduate schools and civilian universities.

ADMINISTRATIVE STAFF

Principal assistants to the Superintendent and Provost are two captains of the line, one supply corp captain, three civilian deans and one civilian director. The military positions are Dean of Students/Director of Programs, Director of Military Operations and Director of Resource Management. The academic positions are Dean of Faculty and Graduate Studies, Dean of Research, Director of Information Systems and Dean of Instruction. These positions are currently held by:

DEAN OF FACULTY

John P. Powers,
Professor of Electrica
and Computer Engineering

DEAN OF STUDENTS/DIRECTOR OF PROGRAMS

Gregory A. Bushnell
Captain, U.S. Navy

DIRECTOR OF MILITARY OPERATIONS

John Schmidt
Captain, U.S. Navy

DIRECTOR OF INFORMATION SERVICES

Maxine Reneker
Professor of Library Sciences

DEAN OF RESEARCH

Paul Marto
Distinguished Professor
of Mechanical Engineering

DEAN OF INSTRUCTION

Richard E. Elster
Professor of Systems Management

DIRECTOR OF RESOURCE MANAGEMENT

Steve Kesselring
Captain, U.S. Navy

ACADEMIC DEPARTMENTS AND GROUPS

Members of the faculty are organized into eleven Academic Departments and four interdisciplinary Academic Groups. Each is supervised by a chairman who reports to the Dean of Faculty. Over 80% of the teaching staff are civilians of varying professional rank and the remainder are military officers.

ACADEMIC DEPARTMENTS

- Aeronautics and Astronautics
- Computer Science
- Electrical and Computer Engineering
- Mathematics
- Mechanical Engineering
- Meteorology
- National Security Affairs
- Oceanography
- Operations Research
- Physics
- Systems Management

ACADEMIC GROUPS

- Command, Control and Communications
- Electronic Warfare
- Space Systems
- Undersea Warfare

CURRICULAR OFFICES

The Curricular Offices are organizational entities that are separate from, but interactive with, the Academic Departments in the educational operations of the school. The former are staffed by naval officers and civilian faculty members whose primary functions are threefold: (1) academic counseling and military supervision of officer students, (2) curriculum development and management to ensure attainment of professional and academic objectives, and (3) liaison with curricular sponsor representatives.

Students are grouped in accordance with their curricular programs and are assigned to one of ten Curricular Offices for program supervision and for academic and professional counseling.

Students in each curricular group pursue similar or closely related curricula. Each Curricular Office is staffed by one or more military officers of suitable experience and rank and one or more Academic Associates. The latter are faculty members selected for this part-time assignment. They are responsible to the Deans for the integrity and academic soundness of the academic features of the Curricular Office operations. Curricular Officers ensure their curricula meet Navy needs and ensure the proper administrative operation of their respective offices. They report to the Director of Programs.

The table beginning on page 15 summarizes the curricula offered through the Naval Postgraduate School. Specific academic requirements for enrollment are contained in each curriculum segment.

Students entering any of the technical curricula normally are ordered to a six-week mathematics refresher course. It begins in the seventh week of each quarter. This course is not designed to teach math, but rather to acquaint students with calculus. During this refresher, students also take an introductory course in set and logic theory and a programming course on desk-top microcomputers.

Some officers are ordered to Engineering Science (Curriculum 460) if they require more preparation for entering one of the technical curricula. This program is either one or two quarters long and includes calculus, physics and other preparatory courses.

INTERNATIONAL PROGRAMS OFFICE

The International Programs Office is responsible for the cultural, social and academic integration of the international community. The office is charged with interacting with the outside agencies, military and civilian to accomplish the goals of the Security Assistance Training Program (SATP) and the Information Program (IP). Additionally, it is responsible for the International Sponsor Program and acts as the Command Sponsor to the International Committee.

Since 1961 over 2900 International officers from 55 countries have graduated from NPS. Many have gone on to achieve positions of prominence within their military services, governments, and private industry. The International Program at NPS serves as an integral link in establishing the long term military-to-military relationships between our US and allied officers. The International Programs Office sponsors the courses; **IT1500 American Life and Institutions (3-0)**, which acquaints International students with the variety of political, social, economical, and cultural viewpoints to be found in the US, and **IT1600 Communication Skills for International Officers (4-2)**, which is designed to increase the student's ability and comprehension in communicating effectively in written and spoken English.

NPS CURRICULA SUMMARY

| Curriculum | Curriculum Number | Normal Length (Months) | Normal Convening Dates | Cognizant Curricular Office Code |
|---|----------------------|------------------------------|------------------------------|--|
| Aeronautical Engineering | | | | |
| Aeronautical Engineering..... | 610 | 24 | April/October | 31 |
| Aeronautical Engineering with Avionics | 611 | 24 | April/October | 31 |
| Meteorology and Oceanography | | | | |
| Meteorology | 372 | 21 | Any Quarter | 35 |
| METOC | 373 | 27 | Any Quarter | 35 |
| Operational Oceanography | 374 | 24 | Any Quarter | 35 |
| Oceanography | 440 | 24-36 | Any Quarter | 35 |
| Combat Systems Sciences and Technology | | | | |
| | 533 | 27 | April/October | 33 |
| Electronics & Computer Programs | | | | |
| Computer Science..... | 368 | 24 | April/October | 32 |
| Electronics Systems | 590 | 21-27 | Any Quarter | 32 |
| Joint Command, Control and Communications | | | | |
| Command, Control and Communications | 365 | 21 | October | 39 |
| National Security and Intelligence | | | | |
| Middle East, Africa, South Asia | 681 | 18 | January/July | 38 |
| Far East, Southeast Asia Pacific | 682 | 18 | January/July | 38 |
| Western Hemisphere | 683 | 18 | January/July | 38 |
| Russia, Europe, Central Asia | 684 | 18 | January/July | 38 |
| Strategic Planning | 688 | 24 | January/July | 38 |
| Special Operations/ Low Intensity Conflict | 699 | 18 | July | 38 |
| Resource Planning and Management for International Defense | 820 | 18 | January | 36 |
| Intelligence (S&T) | 825(I) | 20 | February | 38 |
| Intelligence (Regional Studies)..... | 825(II) | 24 | January/July | 38 |
| Intelligence (OPINTEL) | 825(III) | 18 | July | 38 |
| Naval/Mechanical Engineering | | | | |
| Naval/Mechanical Engineering | 570 | 24-27 | Any Quarter | 34 |
| Operations Analysis | | | | |
| Operations Analysis | 360 | 24 | April/October | 30 |
| Operational Logistics | 361 | 24 | October | 30 |
| Advanced Science (Applied Math) | 380 | 24 | January/July | 30 |
| Systems Management | | | | |
| Information Technology Management..... | 370 | 24 | April/October | 36 |

| Curriculum | Curriculum Number | Normal Length (Months) | Normal Convening Dates | Cognizant Curricular Office Code |
|--|----------------------|------------------------------|------------------------------|--|
| Transportation Logistics Management | 813 | 21 | July | 36 |
| Transportation Management | 814 | 21 | July | 36 |
| Acquisition & Contract Management | 815 | 18 | January, July | 36 |
| Systems Acquisition Management | 816 | 21 | January, July | 36 |
| Allied Officers, DoD Civilians, USA, USMC and USCG | 817 | 18 | January, July | 36 |
| Defense Systems Management | 818 | 18 | January, July | 36 |
| Systems Inventory Management | 819 | 18 | July | 36 |
| Resource Planning and Management for International Defense | 820 | 18 | January | 36 |
| Material Logistics Support Management | 827 | 18 | January, July | 36 |
| Financial Management | 837 | 18 | January, July | 36 |
| Manpower/Personnel Training Analysis | 847 | 21 | July | 36 |
| Undersea, Space and Electronic Warfare | | | | |
| Space Systems Operations International | 364 | 24 | October | 37 |
| Space Systems Operations | 366 | 24 | October | 37 |
| Undersea Warfare | 525 | 24 | April/October | 37 |
| Undersea Warfare International . | 526 | 24 | April/October | 37 |
| Space Systems Engineering | 591 | 27 | April/October | 38 |
| Electronic Warfare Systems Engineering | 595 | 24 | October | 37 |
| Electronic Warfare International | 596 | 24 | October | 37 |

Each service identifies military billets that require specific graduate level education for successful performance. More than 6,000 subspecialty coded billets are presently identified in the Navy. Quotas for officer inputs to graduate education programs are generated annually to meet current and projected billet requirements. Sponsors such as the Naval Sea Systems Command and Naval Air Systems Command identify the skill requirements for subspecialty coded billets, and the Naval Postgraduate School administers curricular programs to meet the promulgated skill requirements. Curriculum titles, minimum threshold APC levels, subspecialty codes and degree titles are listed below by ascending curriculum number.

| Curriculum Number | Curriculum Title | Admission APC | Subspecialty Code | Degree |
|-------------------|--|---------------|-------------------|--|
| 360 | Operations Analysis | 324 | XX42P | MS Operations Research |
| 361 | Operational Logistics | 324 | XX43P | MS Operations Research |
| 365 | Command, Control & Communications (C3) | 325 | XX45P | MS Systems Tech (C3) |
| 366 | Space Systems Operations | 324 | XX76P | MS Systems Tech (Space Sys. Ops) |
| 368 | Computer Science | 325 | XX91P | MS Computer Science |
| 370 | Information Technology Management | 325 | XX89P | MS Information Technology Management |
| 372 | Meteorology | 323 | XX48P | PhD Only for USN officers |
| 373 | METOC | 323 | XX47P | MS Meteorology & Physical Oceanography |
| 374 | Operational Oceanography | 323 | XX49P | MS Physical Oceanography |
| 380 | Applied Mathematics | 324 | XX41P | MS Applied Mathematics |
| 440 | Oceanography | 323 | XX49D | PhD Only for USN officers |
| 525 | Undersea Warfare | 323 | XX44P | MS Applied Science, Applied Physics, Physical Oceanography, Electrical Engineering or Engineering Acoustics |
| 533 | Combat Systems Sciences | 323 | XX66P | MS Applied Physics, Physics, & Technology Engineering Acoustics, Computer Science, Aeronautical Engineering, Electrical Engineering, Mechanical Engineering, Material Science. |
| 570 | Naval/Mechanical Engineering | 323 | XX54P | MS Mechanical Engineering |
| 590 | Electronic Systems Engineering | 323 | XX55P | MS Electrical Engineering |
| 591 | Space Systems Engineering | 323 | XX77P | MS (Various) |
| 595 | Electronic Warfare Systems Engineering | 324 | XX46P | MS Systems Engineering |
| 596 | Electronic Warfare Systems International | 324 | NONE | MS Systems Engineering |
| 610 | Aeronautical Engineering Engineering | 323 | XX71P | MS Aeronautical |
| 611 | Aeronautical Engineering-Avionics | 323 | XX72P | MS Aeronautical Engineering |
| 681 | National Security Affairs | 365 | XX21P | MA National Security Affairs (Middle East, Africa, South Asia) |
| 682 | National Security Affairs | 365 | XX22P | MA National Security Affairs (Far East, Southeast Asia, Pacific) |
| 683 | National Security Affairs | 365 | XX23P | MA National Security Affairs (Western Hemisphere) |
| 684 | National Security Affairs | 365 | XX24P | MA National Security Affairs (Russia, Europe, Central Asia) |
| 688 | National Security Affairs (Strategic Planning) | 335 | XX28P | MA National Security Affairs |
| 699 | National Security Affairs (Special Operations/ Low Intensity Conflict) | 365 | XX29P | MA National Security Affairs |

| Curriculum Number | Curriculum Title | Admission APC | Subspecialty Code | Degree |
|-------------------|--|---------------|-------------------|---|
| 813 | Transportation Logistics Management | 345 | 1304P | MS Management |
| 814 | Transportation Management | 345 | XX35P | MS Management |
| 815 | Acquisitions & Contract Management | 345 | 1306P | MS Management |
| 816 | Systems Acquisition Management | 345 | None | MS Management |
| 817 | Defense Systems Analysis | 345 | None | MS Management |
| 818 | Defense Systems Management | 345 | None | MS Management |
| 819 | Systems Inventory Management | 345 | 1302P | MS Management |
| 820 | Resource Planning/Mgmt for International Defense | 345 | None | MS International Resource Planning and Management |
| 825(I) | Intelligence(S&T) | 223 | XX17P | MS National Security Affairs |
| 825(II) | Intelligence (Regional Studies | 365 | XX18P | MA National Security Affairs |
| 825(III) | Intelligence (OPINTEL) | 235 | XX19P | MA National Security Affairs |
| 827 | Material Logistics Support Management | 345 | XX32P | MS Management |
| 837 | Financial Management | 345 | XX31P | MS Management |
| 847 | Manpower, Personnel & Training Analysis | 345 | XX33P | MS Management |

FACULTY ORGANIZATIONS

The faculty plays a role in school-wide policy making and planning through various established Councils. The Faculty Council functions as a primary faculty input advisory vehicle to the Provost and Superintendent. The Academic Council, a representative body of each academic department and group, has cognizance over all academic standards and degree-granting considerations. The composition of each Council and its specific functions are described in the NPS Organization and Regulations Manual.

STUDENT COUNCIL

The Officer Student Advisory Council (OSAC) is an organized communication mechanism between the NPS students and the NPS administration. It functions in an advisory capacity in matters involving curricula, facilities, procedures and policies deemed worthy of attention. The OSAC is comprised of thirty-five student representatives and membership is distributed among the curricula by student population, with each curriculum having at least one representative.

The OSAC is headed by a Chairman, Vice Chairman and Secretary elected by members of the Student Council. Officers serve for a six-month period.

Besides a Steering Committee and an Election Committee, Student Council committees are formed to correspond with those NPS committees or councils which have an impact or effect on the student body and which can give or receive benefit from such representation. OSAC representation is included in the following NPS standing Councils and Committees:

- Academic Council
- Faculty Council
- Library Council
- Exchange/Bookstore Committee

ADMISSIONS

U.S. Navy officers interested in attending one of the curricula offered at the Naval Postgraduate School are referred to OPNAVINST 1520.23 and to the latest OPNAVNOTE 1520. These documents provide guidance, information and policy for the Navy's fully funded graduate education program.

SELECTION PROCEDURES

NAVAL OFFICERS

Selection for the Navy fully funded graduate education program is based on outstanding professional performance, promotion potential and a strong academic background. Officers interested in this program should contact their assignment officer to determine **professional** qualification status; upon determination of academic qualification (by NAVPGSCOL), individuals are eligible for assignment. Officers who are professionally qualified but lack academic qualifications should contact the Director of Admissions for information on ways to improve their academic background.

OTHER U.S. MILITARY OFFICERS

Officers on duty with other branches of service are eligible to attend the Postgraduate School. Requests for admission or transcripts from individual officers should not be sent directly to the Naval Postgraduate School. They should apply in accordance with the directives promulgated by the Department of the Army, Department of the Air Force, Commandant U.S. Marine Corps or the Commandant U.S. Coast Guard, as appropriate.

INTERNATIONAL STUDENTS

Military officers and government civilian employees from other countries may be admitted to most curricula. The procedures for application are available from the Security Assistance Office or Defense Attache Office of the U.S. Embassy, the MLO, MAAG or ODC, as appropriate. Correspondence must be processed through official channels; requests from individual prospective students should not be sent directly to the School. In addition to English language comprehension, as demonstrated by current results of the Test of English as a Foreign Language (TOEFL) and the Test of Written English (TWE), candidates must satisfy the curriculum academic standards, as described in this catalog.

CIVILIAN EMPLOYEES OF U.S. GOVERNMENT

A civilian employee of an agency of the United States Federal Government may be admitted for study upon request and sponsorship of the agency. Federal civilian employees are not required to pursue the curricula designed for officer-students as described in this catalog but instead determine, with the guidance of assigned academic counselors, the combination of courses that will best meet their needs.

A civilian who is expecting agency sponsorship should submit a written request for evaluation for admission at least six months prior to expected commencement of studies. A request should indicate the desired curriculum and degree intentions and be accompanied by a complete set of official transcripts of all previous college work. GRE and/or GMAT scores are required for consideration for admission to any doctoral program.

Requests for admission should be directed to the Director of Admissions, Code 62, Naval Postgraduate School, 589 Dyer Rd., RM 103C, Monterey, CA 93943-5100. Questions about available programs or admission procedures may be telephoned to (408) 656-3093 or DSN 878-3093.

Any civilian employee of the United States Government is eligible to participate in the programs of the School. The individual's employing agency is expected to meet the tuition expense for regular on-campus enrollment.

Programs available to civilian students can be classified as follows:

Regular Curricula: The School's programs for officers are designed to meet the requirements of the services for specific education. The contents usually exceed the requirements for a graduate degree since the service's requirements, rather than degree requirements, determine the scope of each program. Civilian students may enter any curriculum at the point at which they are qualified and complete the curriculum along with regular officer students. The Programs section describes the available curricula.

Degree Programs: For civilian students, programs may be designed which lead to the award of a graduate degree while meeting the educational goals of each individual. In order to minimize the residency requirement, an off-campus preparatory program may be developed in consultation with a school advisor. If the available time in residence is insufficient to complete degree requirements, the thesis-project portion of the program may be completed off-campus.

Non-Degree Programs: Civilian employees may desire to pursue a program for professional advancement without a degree objective. For groups of employees from an agency, special courses can be offered to meet particular requirements, provided the demand is in an area of expertise of the school.

Admission: For admission to either a degree or a non-degree program, whether on-campus or by distance learning, the minimum qualification is an accredited baccalaureate degree with appropriate preparation for the proposed program. The school will require submission of official transcripts covering all college work completed to date.

CATALOGS

The point of contact for requests for Naval Postgraduate School Catalogs and admission to resident study programs is:

Director of Admissions
Code 62, Naval Postgraduate School,
589 Dyer Rd., RM 103C
Monterey, CA 93943-5100
Telephone (408) 656-3093 / DSN 878-3093

ACADEMIC PROFILE CODES

The Academic Profile Code (APC) is a three-digit code which summarizes pertinent portions of an officer's prior college performance. The Naval Postgraduate School routinely generates APCs for officers of most Navy communities, usually within three years of commissioning. The three independent digits reflect an individual's cumulative grade-point average (QPR), exposure to and performance in calculus-related mathematics courses and exposure to and performance in selected science/engineering areas.

First Digit

The first digit indicates overall academic performance and is derived from the following table:

| <u>Code</u> | <u>QPR Range</u> |
|-------------|------------------|
| 0 | 3.60-4.00 |
| 1 | 3.20-3.59 |
| 2 | 2.60-3.19 |
| 3 | 2.20-2.59 |
| 4 | 1.90-2.19 |
| 5 | 0 -1.89 |

(Failures and repeated courses are included in the QPR calculation.)

Second Digit

The second digit represents mathematical background according to the following criterion:

| <u>Code</u> | <u>Meaning</u> |
|-------------|---|
| 0 | Significant post-calculus math with B or better average (Math Major or strong Math Minor) |
| 1 | Calculus sequence completed with B+ or better average |
| 2 | Calculus sequence completed with average between C+ and B |
| 3 | One calculus course with C or better |
| 4 | Two or more pre-calculus courses with B or better average |
| 5 | One pre-calculus with C or better grade |
| 6 | No college level calculus or pre-calculus math with a grade of C or better |

Third Digit

The third digit represents previous course coverage in science and technical fields.

| <u>Code</u> | <u>Meaning</u> |
|-------------|--|
| 0 | Significant pertinent upper-division technical courses with B+ or better average |
| 1 | Significant pertinent upper-division technical courses average between C+ and B |
| 2 | Complete calculus-based physics sequence with B+ or better average |
| 3 | Complete calculus-based physics sequence with average between C+ and B |
| 4 | One calculus-based physics course with C or better grade |
| 5 | No pertinent technical courses |

A first digit code of 0, 1, 2, or 3 (as appropriate) will be assigned only if transcripts provided exhibit at least one hundred semester hours or one hundred fifty quarter hours of actual graded classroom instruction. Grades of Pass/Fail, Credit/No Credit will not count toward the 100/150 hour requirement.

A technical code of 1 or 0 ordinarily is assigned only to an officer whose undergraduate major was Physics, Aeronautical, Electrical, Mechanical or Naval Engineering, or whose undergraduate technical major is consistent with the officer's designator.

Example

An APC of 221 indicates a total grade average for all college courses in the interval 2.60-3.19, a complete sequence in calculus-of-one-variable with a C+ or B average and a major in physics or pertinent engineering area with upper-division courses with a C+ or B average.

Threshold

Each curriculum at the Naval Postgraduate School has a specified threshold APC for admission. A list of these is given at the beginning of the section on programs. Officers with deficient APCs may qualify for entry into these curricula by completing suitable courses at any accredited civilian college. Transcripts (not grade reports) of work done at civilian schools must be forwarded to the Director of Admissions, Code 62, Naval Postgraduate School, 589 Dyer Rd., RM 103C, Monterey, CA 93943-5100, to effect an APC change. The grades in all courses completed will be used to revise an officer's QPR.

GENERAL INFORMATION

COURSE CODES

Courses are designated by an alpha-numeric symbol consisting of two letters and four numbers. The first two letters designate the academic department which offers the course and are defined as follows:

| | |
|-------------------------------------|----|
| Aeronautics and Astronautics | AA |
| Command, Control and Communications | CC |
| Computer Science | CS |
| Electrical and Computer Engineering | EC |
| Electronic Warfare | EW |
| Interdisciplinary Courses | EO |
| International Programs | IT |
| Mathematics | MA |
| Mechanical Engineering | ME |
| Total Ship System Engineering | TS |
| Materials Science | MS |
| Meteorology | MR |
| National Security Affairs | NS |
| Oceanography | |
| Oceanographic Sciences | OC |
| Operations Research | |
| Operations Analysis | OA |
| Service Courses | OS |
| Physics | PH |
| Science and Engineering | SE |
| Space Systems | SS |
| Systems Management | |
| Information Systems | IS |
| Management | MN |
| Services Courses | AS |
| Undersea Warfare | UW |

Courses are assigned numbers in accordance with their level of academic credit:

| | |
|-----------|---|
| R001-R999 | Technical Refresher (no credit) |
| 0001-0999 | No credit |
| 1000-1999 | Lower division college credit (Freshman - Sophomore Level) |
| 2000-2999 | Upper division college credit (Junior - Senior level) |
| 3000-3999 | Upper division college or graduate credit |
| 4000-4999 | Graduate credit |

Following the course designator are two numbers in parentheses separated by a hyphen which indicate the hours of instruction per week in the classroom and in the laboratory, respectively. Laboratory hours are assigned half the value shown in calculating quarter hours for the credit value of the course. Thus a (3-2) course, having three hours lecture and two hours laboratory, will be assigned a credit value of four quarter hours.

GRADING

Student academic performance is evaluated in terms of quality points assigned to the letter grade achieved in a course. Based on the level of achievement associated with each letter grade, the corresponding quality point values range from a maximum of 4 to a minimum of 0 as follows:

| <u>Grade</u> | <u>Point Value</u> |
|--------------|--------------------|
| A | 4 |
| A- | 3.7 |
| B+ | 3.3 |
| B | 3 |
| B- | 2.7 |
| C+ | 2.3 |
| C | 2 |
| C- | 1.7 |
| D+ | 1.3 |
| D | 1 |
| X | 0 |

Letter designations for which no quality points are assigned are given as follows:

| | |
|---|-----------------|
| I | Incomplete |
| W | Withdrew |
| N | Ungraded |
| P | Pass |
| F | Fail |
| T | Thesis Research |

The grade of Incomplete is given when an identifiable portion of the course remains undone at the end of the quarter. One additional quarter is granted to submit the delinquent work. If the "I" is not removed within the twelve weeks following the end of the term in which it was assigned, it becomes an "X."

A student may withdraw from a course up to the end of the second week of the quarter without any record of it showing on the transcript. Withdrawals may be made after that up to the end of the eighth week of the quarter, but a grade of "W" is entered for the course on the transcript. No withdrawals can be made after the eighth week.

Courses may be designated for "P" and "F" grading when approved by the Academic Department and the Academic Council. A student in a degree program who wishes to take courses not in his or her normal program may elect to take them in the Pass/Fail mode. Approval must be granted by the student's cognizant Curricular Officer and Department Chairman. It is the responsibility of the student to exercise the P/F option by informing the instructor in writing at the time of enrollment that a P/F grade is desired. A copy of the approved request shall be forwarded to the Registrar. Students electing to receive the P/F grade in letter graded courses may not apply the hours toward the degree and curriculum requirements of any program.

QUALITY POINT RATING (QPR)

When the quarter-hour credit of a course is multiplied by the point value of the student's grade, a quality point value for the student's work in the course is obtained. The sum of the quality points for all courses divided by the sum of the quarter-hour credit of these courses gives a weighted numerical evaluation of the student's performance, termed the Quality Point Rating (QPR). A student achieving a QPR of 3.0 has maintained a "B" average in all courses undertaken with a proper weight assigned for course hours.

ACADEMIC COUNSELING

The NAVPGSCOL provides academic counseling services as indicated below to assist officers in developing individual educational plans. Officers who have chosen specific curricula or who have been selected or detailed for graduate education in programs at NAVPGSCOL, are advised to contact the appropriate NAVPGSCOL curricular office listed in the Programs Section of this catalog. Officers not yet selected for graduate education and seeking general information about the curricula offered at the school, or for general information on the fully-funded graduate education selection process, are advised to contact the Director of Admissions (Code 62), NAVPGSCOL, or telephone (408)656-3093, DSN 878-3093.

COURSE REGISTRATION AND CREDIT

Each student must be registered in each course in which he/she is a candidate for credit not later than the end of the second week of the term. No student will receive credit for a course unless registration in that course has been approved by one of the following: the student's Curricular Officer or Academic Associate, the Chairman of his/her doctoral committee, or the Dean of Instruction.

Overload: A student may not enroll for more than 18 total credit hours or more than four 3000 and/or 4000 courses (excluding laboratories or explicit curriculum requirements) per quarter unless he or she has either a total QPR of at least 3.50 or permission of the Department or Group Chairman and the Dean of Instruction.

Repetition of Courses: A student may repeat a course for the purpose of improving a grade provided such course repetition is taken at the Postgraduate School. Approval must be granted by both the Curricular Officer and the Department or Group Chairman concerned and the Registrar is to be notified.

For record purposes, both the original and the repeated courses are to be shown on the transcript. For Quality Point Rating computation, the credit hours of the course shall be counted once, using the grade received from the most recent time that the student enrolled in the course.

Medical Absence: The academic record of a student may be deleted completely for a given term when the student is absent for a portion of the term for medical reasons. The transcript will show, "Excused for the term for medical reasons." The student shall not be permitted to delete only a portion of the courses for this reason. The grade "W" shall be used when it is necessary to withdraw from only a part of the student's program. Such excusals shall be requested by the Curricular Officer and approved by the Dean of Instruction.

Credit by Examination: The award of credit solely on the basis of examination for any 1000 or 2000 level course is permissible. Grades for such courses shall be awarded on a Pass/Fail basis.

VALIDATION

A student with the appropriate background may validate a course that is required for his/her curriculum. Validation will allow the student to omit that course from the program of study; however, no credit will be granted for a course that has been validated. The basic purpose of course validation is to make optimal use of the student's time at the Naval Postgraduate School. Every validation must be justified by documented evidence of prior work in the area of the course to be validated.

The validation of a course must be approved in writing by the Chairman of the department offering the course or a designated representative. Specific criteria for validation (e.g., review of the student's transcripts or examination on the material of the course) are left to the discretion of the cognizant Department Chairman.

After validating one or more courses, it may be possible for a student to complete the program in less than the maximum time allowed.

TRANSFER OF CREDITS

Upon entry to the Naval Postgraduate School, each student's academic record will be evaluated for possible transfer of credit or for exemption from portions of the curricular program by validation of course work previously completed. Students may also utilize knowledge gained through self-study, experience of service-related education to seek validation, or credit for curricular courses by taking a departmental examination.

Twelve hours of graduate-level courses previously completed may be accepted for transfer credit. These include graduate-level courses taken after completion of the

baccalaureate degree and those taken in the last term before award of the baccalaureate and certified to be in excess of degree requirements.

Questions on transfer credit should be directed by letter to the appropriate curricular Academic Associate, as listed in this catalog.

REQUIREMENTS FOR THE MASTER OF ARTS DEGREE AND THE MASTER OF SCIENCE DEGREE

The Master's Degree may be awarded for successful completion of a curriculum which has the approval of the Academic Council as meriting the degree. Such curricula shall conform to current practice in accredited institutions and shall contain a well-defined major.

General Postgraduate School minimum requirements for the Master's Degree are as follows:

- 32 quarter hours of graduate level credits of which at least 20 quarter hours must be earned on campus.
- A thesis or its equivalent is required. If the thesis is waived, at least 8 quarter hours of approved courses 4000 - 4999 shall be substituted for it.

Admission to a program leading to the Master's degree requires:

- General undergraduate work as defined in Section 320 of the Academic Policy Manual.
- Appropriate undergraduate preparation for the curriculum to be pursued. A student entering the Postgraduate School with inadequate undergraduate preparation will be required to complete the undergraduate prerequisites in addition to the degree requirements.
- A demonstrated academic potential for completing the curriculum.

To be eligible for the Master's degree, the student must attain a minimum average quality point rating of 3.00 in all of the 3000 and 4000 level courses in his/her curriculum and either 2.5 in the remaining courses or 2.75 in all courses of the curriculum.

DUAL DEGREE PROGRAMS

Students who wish to pursue a dual degree program must satisfy QPR and other curricular/departmental requirements, as set forth in the Academic Council Policy Manual.

Educational Skill Requirements

Establishing Educational Skill Requirement (ESR) is a two step process. The first step is for the curricular sponsor to establish areas of study that are needed to support Navy needs. The second is for NPS to develop the actual courses of study that will meet these requirements.

Both steps are accomplished as a cooperative effort by the sponsor and NPS. The second step is necessarily more specific, especially with regard to areas of military application that are to be covered. In many cases it is necessary to write more specific guidance to the faculty that the original ESRs convey in order to insure sponsor needs are met. This results in the internal, or detailed, ESRs. Detailed ESRs for all of the curricula offered

at NPS are included at the end of each curricular office section.

It is important to point out that curricular content is a continual discussion item between NPS Curricular Officers and faculty Academic Associates and officers in the sponsor's office. This includes the sponsor providing or making available material to be used in class, providing lists of suggested thesis topics, and providing opportunities and financial support for student experience tours. It is the School's experience that only with such an extended process (a partnership) can we insure that sponsor needs are met.

CURRICULA CONDUCTED AT OTHER UNIVERSITIES

The Navy's fully-funded graduate education program supports 71 subspecialties. This involves 78 curricula, 42 at NPS and 36 at over 65 civilian institutions. Programs available at NPS are not offered at civilian institutions. Approximately 20% of the fiscal year officer graduate education assignments are slated for these universities. Where more than one school is listed for a particular curriculum, subspecialty education placement officers plan quota distribution.

In order to qualify for the Civilian Institutions program, officers must be Postgraduate School selected and must meet all the requirements of the civilian institution.

| Curriculum | Number | Length | Institution | Primary Consultant |
|---|--------|------------|-----------------------------------|--------------------|
| Chemistry | 382 | 2 yrs. | Various | NAVSEASYSKOM |
| Criminal Law | 884 | 1 yr. | Various | NJAG |
| Education and Training Management | 867 | 12-18 mos. | Various | CNET |
| Environmental Law | 880 | 1 yr. | Various | NJAG |
| Facilities Engineering | 47X | 1 yr. | Various | NAVACENGKOM |
| Health Care Law | 885 | 1 yr. | Various | NJAG |
| International Law | 887 | 1 yr. | Various | NJAG |
| Joint Intelligence | 990 | 9-12 mos. | JMIC | NAVINTKOM |
| Labor Law | 886 | 1 yr. | Various | NJAG |
| Advanced Military Justice | 881 | 9-12 mos. | JAG School | NJAG |
| Logistics Management | 770 | 15 mos. | Air Force Institute of Technology | NAVARSYSKOM |
| National Security (International Relations and Diplomacy) | 680 | 12 mos. | Various | CNO N511 |
| National Security (International Relations and Diplomacy) | 690 | 12 mos. | Various | CNO N511 |
| Naval Construction and Engineering | 510 | 2-3 yrs. | M.I.T. | NAVSEASYSKOM |
| Nuclear Engineering (ED) | 520 | 2 yrs. | M.I.T. | NAVSEASYSKOM |
| Ocean Engineering | 472 | 15-18 mos. | Various | NAVACENGKOM |
| Ocean Law | 883 | 1 yr. | Various | NJAG |
| Operational Oceanography | 375 | 27 mos. | M.I.T. | CNO OP-096 |
| Petroleum Management | 811 | 18-21 mos. | University of Kansas | NAVSUPSYSKOM |
| Petroleum Engineering | 630 | 12-24 mos. | Various | NAVACENGKOM |
| Public Affairs | 920 | 1 yr. | Various | CHINFO |
| Religion | 97X | 9 mos. | Various | CHCHAP |
| Retailing | 830 | 18-21 mos. | Various | NAVSUPSYSKOM |
| Subsistence Technology | 860 | 18-21 mos. | Michigan State | NAVSUPSYSKOM |
| Supply Acquisition/ Distribution Management | 810 | 18-21 mos. | Various | NAVSUPSYSKOM |
| Tax Law | 882 | 1 yr. | Various | NJAG |

Inquiries concerning curricula conducted at other universities should be directed to:

Director of Civilian Institutions Programs
Code 031
Naval Postgraduate School
589 Dyer Rd, Room 228
Monterey, CA 93943-5143

Detailed information including applicable designators and the list of approved civilian institutions for the above curricula may be found in OPNAVNOTE 1520.

AEROSPACE ENGINEERING PROGRAMS

Curricula Officer:

Wade D. Duym
CDR, USN
Code 31, Halligan Hall
Room 133
(408) 656-2491
DSN 878-2491

AERONAUTICAL ENGINEERING AND AERONAUTICAL ENGINEERING (AVIONICS) CURRICULA 610 and 611

The Aerospace Engineering programs are designed to meet the specific needs of the Navy for technical managers with a broad-based graduate education in Aeronautical Engineering. While an undergraduate degree in engineering is preferred, special preparatory programs can accommodate officers with backgrounds in mathematics or the sciences.

These programs give the student a broad technical and engineering education in the four principal areas of aeronautics: gas dynamics, flight dynamics, propulsion and flight structures. Additionally, officers receive graduate level instruction in aircraft/missile design and aero-computer science. Students in the 611 curriculum receive primary emphasis on avionics systems. The programs are divided into preparatory, graduate and advanced graduate phases. The preparatory phase is tailored to each officer's background and is programmed for minimum time consistent with capability. After the preparatory phase, a graduate core is completed by both the 610 and 611 students. This phase includes advanced studies in propulsion, aerodynamic analysis, structural analysis and stability and control. During the advanced graduate phase, all students receive in-depth graduate coverage through advanced electives in areas of their choice including flight dynamics, gas dynamics, propulsion and structures. Students in curriculum 611 receive advanced studies in guidance and control, radar systems and electronic warfare, aeronautical data systems and avionics design.

REQUIREMENTS FOR ENTRY

A baccalaureate degree, or its equivalent, with an above-average QPR, preferably in engineering or the physical sciences, is required. In addition, mathematics through differential and integral calculus, with above-average grades and completion of a calculus-based physics sequence with above-average grades is also required. An APC of 323 is the requirement for direct entry, but the Engineering Science Program (Curriculum 460) is available for candidates who do not meet all the admission requirements for direct entry. The required APC for entry via Curriculum 460 is 334.

ENTRY DATES

Aeronautical Engineering is a seven or eight-quarter course of study with entry dates in April and October. Those requiring the Engineering Science Curriculum will have their time of arrival adjusted to accommodate it. If further information is needed, contact the Academic Associate or the Curricular Officer for this curriculum.

Curricula 610 and 611

Academic Associate:

Gerald H. Lindsey, Professor
Code AA/Li, Halligan Hall
Room 223
(408) 656-2808, DSN 878-2808

DEGREE

Requirements for the degree Master of Science in Aeronautical Engineering are met as a milestone en route to satisfying the Educational Skill Requirements of the curricular programs.

AERONAUTICAL ENGINEERING SUBSPECIALTY

Completion of this curriculum qualifies an officer as an Aeronautical Engineering Subspecialist with a subspecialty code of XX71P.

The Curriculum Sponsor and primary consultant is the Naval Air Systems Command.

Typical Jobs in this Subspecialty:

Project Officer: Naval Air Systems Command

Project Officer: Naval Aviation Depot, San Diego, CA

Aircraft Class Desk Officer: COMNAVAIRLANT, Norfolk, VA

Project Officer: Defense Plant Representative Office, St. Louis, MO

TYPICAL COURSE OF STUDY

Refresher Quarter

| | | |
|--------|-------|------------------------------------|
| AAR242 | (5-0) | Fluid Mechanics |
| AAR261 | (5-0) | Solid Mechanics |
| MAR117 | (3-3) | Single Variable Calculus |
| MAR142 | (2-0) | Matrix Algebra |
| MN3221 | (2-0) | Principles of Program Management I |

Quarter 1

| | | |
|--------|-------|---------------------------------------|
| AA2440 | (3-2) | Introduction to Digital Computation |
| MA1118 | (5-2) | Multivariable Calculus |
| MA2121 | (4-1) | Differential Equations |
| NS3252 | (4-0) | Joint and Maritime Strategic Planning |

Quarter 2

| | | |
|--------|-------|-----------------------------------|
| AA2021 | (3-2) | Introduction to Flight Structures |
| AA2035 | (3-2) | Basic Aerodynamics |
| AA2043 | (3-2) | Fundamentals of Gas Dynamics |
| MA2049 | (3-0) | Vector Analysis |

Quarter 3

| | | |
|--------|-------|----------------------------------|
| AA2036 | (3-2) | Performance and Static Stability |
| AA2339 | (3-2) | Aerospace System Dynamics |
| AA2801 | (3-2) | Aero - Laboratories I |
| MA3132 | (4-0) | Partial Differential Equations |

Quarter 4

| | | |
|--------|-------|--------------------------------------|
| AA3101 | (3-2) | Flight Vehicle Structural Analysis |
| AA3340 | (3-2) | Dynamic Stability Aerospace Vehicles |
| AA3451 | (3-2) | Aircraft and Missile Propulsion |
| AA3501 | (3-2) | Aerodynamic Analysis |

Quarter 5

| | | |
|--------|-------|--|
| AA3202 | (3-2) | Structural Failure, Fracture and Fatigue |
| AA4341 | (3-2) | Control of Aerospace Vehicles |
| AA0810 | (0-8) | Thesis Research |
| MA3232 | (4-1) | Numerical Analysis |

Quarter 6

| | | |
|--------|-------|-------------------------------|
| AA3251 | (4-1) | Aircraft Combat Survivability |
| AA4273 | (3-2) | Aircraft Design |
| AA0810 | (0-8) | Thesis Research |
| AA4XXX | (4-0) | Elective |

Quarter 7

| | | |
|--------|-------|-------------------------------------|
| AA3802 | (3-2) | Aeronautical Measurement Techniques |
| AA0810 | (0-8) | Thesis Research |
| AA0810 | (0-8) | Thesis Research |
| MN3222 | (4-0) | Principles of Program Management II |

AERONAUTICAL ENGINEERING (AVIONICS) SUBSPECIALTY

Completion of this curriculum qualifies an officer as an Aeronautical Engineer with an Avionics Subspecialty and a subspecialty code of XX72P. The Curriculum Sponsor is the Naval Air Systems Command.

Typical Jobs in this Subspecialty:

Avionics Class Desk Officer: COMNAVAIRLANT, Norfolk, VA
Avionics Systems Project Officer: Naval Air Systems Command
Deputy Program Manager: Naval Air Systems Command
Project Officer: Naval Air Warfare Center (Aircraft Division), Patuxent, MD

TYPICAL COURSE OF STUDY

Refresher Quarter

| | | |
|--------|-------|------------------------------------|
| AA242 | (5-0) | Fluid Mechanics |
| MAR118 | (3-3) | Multivariable Calculus |
| MAR142 | (2-0) | Matrix Algebra |
| MN3221 | (2-0) | Principles of Program Management I |
| PHR110 | (5-3) | Dynamics |

Quarter 1

| | | |
|--------|-------|-------------------------------------|
| AA2440 | (3-2) | Introduction to Digital Computation |
| EO2402 | (4-1) | Introduction to Linear Systems |
| MA2049 | (4-0) | Vector Analysis |
| MA2121 | (4-1) | Differential Equations |

Quarter 2

| | | |
|--------|-------|----------------------------------|
| AA2035 | (3-2) | Basic Aeronautics |
| AA2043 | (3-2) | Fundamentals of Gas Dynamics |
| EO2602 | (4-0) | Introduction to Fields and Waves |
| EO3402 | (4-1) | Signal Processing Systems |

Quarter 3

| | | |
|--------|-------|----------------------------------|
| AA2036 | (3-2) | Performance and Static Stability |
| AA2339 | (3-2) | Aerospace System Dynamics |
| EO2612 | (4-0) | Electromagnetic Engineering |
| MA3042 | (4-0) | Linear Algebra |

Quarter 4

| | | |
|--------|-------|---|
| AA3340 | (3-2) | Dynamic Stability of Aerospace Vehicles |
| AA3501 | (3-2) | Aerodynamic Analysis |
| EO3512 | (3-1) | Communications and Countermeasures |
| EO3602 | (4-2) | Electromagnetic Radiation, Scattering and Propagation |

Quarter 5

| | | |
|--------|-------|---------------------------------------|
| AA3276 | (3-2) | Introduction to Avionics |
| AA4341 | (3-2) | Control of Aerospace Vehicle |
| CS3010 | (4-0) | Computer Systems Principles |
| NS3252 | (4-0) | Joint and Maritime Strategic Planning |

Quarter 6

| | | |
|--------|-------|--|
| AA4276 | (3-2) | Avionics Design |
| AA4342 | (4-0) | Advanced Control for Aerospace Systems |

| | | |
|--------|-------|-----------------------------|
| AA0810 | (0-8) | Thesis Research |
| EC3670 | (4-2) | Principles of Radar Systems |

Quarter 7

| | | |
|--------|-------|-------------------------------------|
| AA0810 | (0-8) | Thesis Research |
| AA4641 | (3-2) | Digital Avionics Systems |
| EC4670 | (4-1) | Electronic Warfare Systems |
| MN3222 | (4-0) | Principles of Program Management II |

Quarter 8

| | | |
|--------|-------|-------------------------------|
| AA3251 | (4-1) | Aircraft Combat Survivability |
| AA0810 | (0-8) | Thesis Research |
| AA0810 | (0-8) | Thesis Research |
| AA4XXX | (4-0) | Elective |

NPS/TPS COOPERATIVE PROGRAM

A program which combines portions of the 610 curriculum at the NPS with the completed U.S. Naval Test Pilot School syllabus is currently available to selected officers with strong undergraduate engineering backgrounds. After the completion of five quarters of study at NPS, selectees proceed to Patuxent River for the full Test Pilot School Curriculum. This NPS/TPS Cooperative Program results in a test pilot designation, XX73G, the Aeronautical Engineering subspecialty code XX71P and award of the master's degree in Aeronautical Engineering at the completion of the test pilot school.

TYPICAL COURSE OF STUDY

Refresher Quarter

| | | |
|--------|-------|------------------------------------|
| MAR118 | (3-3) | Multivariable Calculus |
| MAR142 | (2-0) | Matrix Algebra |
| MN3221 | (2-0) | Principles of Program Management I |

Quarter 1

| | | |
|--------|-------|-----------------------------------|
| AA2021 | (3-2) | Introduction to Flight Structures |
| AA2035 | (3-2) | Basic Aerodynamics |
| MA2043 | (3-2) | Fundamentals of Gas Dynamics |
| MA2049 | (3-0) | Vector Analysis |

Quarter 2

| | | |
|--------|-------|-------------------------------------|
| AA2339 | (3-2) | Aerospace System Dynamics |
| AA2440 | (3-2) | Introduction to Digital Computation |
| AA3802 | (3-2) | Aeronautical Measurement Techniques |
| MA2121 | (4-1) | Differential Equations |

Quarter 3

| | | |
|--------|-------|---|
| AA3101 | (3-2) | Flight Vehicle Structural Analysis |
| AA3340 | (3-2) | Dynamic Stability of Aerospace Vehicles |
| AA3501 | (3-2) | Aerodynamic Analysis |
| MA3132 | (4-0) | Partial Differential Equations |

Quarter 4

| | | |
|--------|-------|--|
| AA3202 | (3-2) | Structural Failure, Fracture and Fatigue |
| AA4341 | (3-2) | Control of Aerospace Vehicle |
| MA3232 | (4-1) | Numerical Analysis |
| MN3222 | (4-0) | Principles of Program Management II |

Quarter 5

| | | |
|--------|-------|---------------------------------------|
| AA3251 | (4-1) | Aircraft Combat Survivability |
| AA3451 | (3-2) | Aircraft and Missile Propulsion |
| AA4273 | (3-2) | Aircraft Design |
| NS3252 | (4-0) | Joint and Maritime Strategic Planning |

EDUCATIONAL SKILL REQUIREMENTS AERONAUTICAL ENGINEERING CURRICULUM (610)

Officers completing the educational skill requirements for this curriculum are qualified to receive an XX71P subspecialty code. They consist of a core of prescribed aeronautical engineering skills in ten disciplines, which all graduates must acquire; plus a set of five specialization options of advanced topics in aircraft structures, aerodynamics, propulsion, flight mechanics or systems design, which the student may pursue as electives.

CORE REQUIREMENTS

- 1. AIRCRAFT STRUCTURES AND MATERIALS:** Be able to apply U.S. military standards and practices to analyze structural components of tactical and transport aircraft, using engineering analytic methods on idealized models and automated finite element methods on realistic models to determine stresses, strains, deformations and appropriate limiting conditions of yielding, fracture, buckling and fatigue. These analytical skills should be built upon a fundamental understanding of aircraft materials and familiarity with nondestructive means of experimental evaluation, which includes detection of hidden damage and repair of military flight vehicles that might be done up to the depot level.
- 2. FLIGHT MECHANICS:** Be able to calculate all performance parameters for both propeller driven and jet powered military aircraft, and to determine their longitudinal and lateral-directional, static and dynamic stability characteristics. Be able to analyze and design aircraft and missile guidance and control systems, including feedback stabilization schemes and stochastic processes, using classical and modern control techniques.
- 3. AIRCRAFT AND MISSILE PROPULSION:** Understand the principles and operating characteristics of aircraft and missile propulsion engines and be able to analyze the performance of gas turbines through a knowledge of the behavior and design characteristics of the individual components. Be able to perform on-design and off-design cycle analysis and to understand the principles used to position the gas generator operating line on the compressor map. Be able to calculate performance parameters used in engine selection and know the state-of-the-art reasons for limitations on gas turbine engine performance, as well as the potential for future gains in the field. Be able to analyze the performance of rockets and ramjets through a knowledge of the behavior of individual components, and be able to make steady-state, internal ballistic calculations for solid rocket motors.
- 4. AERODYNAMICS:** Be able to use classical analytic, experimental and modern computational techniques of subsonic and supersonic aerodynamics, including laminar and turbulent boundary-layer viscous effects, with or without heat addition, to calculate internal flow properties through inlets, nozzles and engines and external air flow pressure distributions over wings, canards, tails, and other lifting surfaces to determine the resulting lift, drag and pitching moment.

5. **INFORMATION PROCESSING:** Be able to use current computer methods to solve aeronautical engineering problems and possess a knowledge of the application of dedicated avionic and systems computers on board Naval aircraft.
6. **ENGINEERING MATHEMATICS:** Demonstrate analytic ability to apply differential and integral calculus, ordinary and partial differential equations, complex variables, vector calculus, matrix algebra, probability and statistics and numerical analysis in the development of engineering theory and its application to Naval engineering problems.
7. **ELECTRICAL ENGINEERING:** Understand basic electrical circuits, systems and electronic devices as a foundation for interfacing mechanical and electronic systems in aircraft.
8. **SYSTEMS DESIGN:** Be able to integrate all of the disciplines of aeronautics into a design of an aircraft or missile in response to a realistic set of military requirements, specifications, constraints and cost limitations. The design must include considerations for safety, reliability, maintainability and survivability.
9. **JOINT AND MARITIME STRATEGIC PLANNING:** Possess a knowledge of joint and maritime strategic planning to include development and execution of military strategy and the effects of technical developments of warfare; formulation of U. S. policy, roles of military forces, joint planning and current issues in defense reorganization.
10. **RESEARCH, DEVELOPMENT, TEST AND EVALUATION:** Apply principles of project scoping, planning, design and execution to investigate a current research, development, test or evaluation problem of interest to the Department of Defense that culminates in the publication of a thesis of academic quality.

SPECIALIZATION OPTIONS

Listed below are educational skills in five specialization options that may be pursued as advanced topic electives in aeronautical engineering after the core has been completed in that area.

AIRCRAFT STRUCTURES: Obtain experience in the use of finite element codes as they are applied to aircraft and missile structures; be able to analyze composite structural components, including laminates and sandwich construction and understand fabrication and repair techniques; be able to analyze aircraft structural components under dynamic loads.

FLIGHT MECHANICS: Obtain experience in flight test and evaluation by means of an in-flight laboratory and/or flight simulators; Be able to analyze aircraft components for the transient load and unsteady aerodynamics of gusts, buffeting and flutter; Apply principles of linear optimal control, Kalman filtering and H2 and H. techniques to tactical fighters.

AIRCRAFT AND MISSILE PROPULSION: Understand the conversion of energy in aerodynamic design and computational analysis of flow through compressors and turbines; be able to use computer codes to select and size a ramjet or gas turbine engine for a given mission and carry out the preliminary design of its components.

AERODYNAMICS: Be able to analyze steady and unsteady, inviscid and viscous, compressible (including transonic and hypersonic) flows over aircraft, missiles, helicopters and spacecraft and flows through jet engines using modern computational fluid dynamics.

SYSTEMS DESIGN: Expand design experience over that obtained in the core by executing designs to meet a given set of military mission requirements under realistic constraints in one or more of the following areas: fixed wing aircraft, rotary wing aircraft, tactical missiles and/or aircraft gas turbine engines and explore optimizations of these designs.

EDUCATIONAL SKILL REQUIREMENTS AERONAUTICAL ENGINEERING (AVIONICS) CURRICULUM (611)

Officers completing the educational skill requirements for this curriculum are qualified to receive an XX72P subspecialty code. They consist of a core of prescribed aeronautical engineering skills in nine disciplines, which all graduates must acquire; plus a set of four specialization options of advanced topics in flight mechanics, information processing, electrical engineering and systems design, which the student may pursue as electives.

CORE REQUIREMENTS

1. **STRUCTURES:** Possess a knowledge of basic structural concepts of stress, strain, and deflections and their interrelationships and be able to analyze beams in simple bending, shafts transmitting torque, thin-walled vessels subjected to internal pressure and buckling of long columns.
2. **FLIGHT MECHANICS:** Be able to calculate all performance parameters for both propeller driven and jet powered military aircraft, and to determine their longitudinal and lateral-directional, static and dynamic stability characteristics. Be able to analyze aircraft and missile guidance and control systems, using deterministic and stochastic theory, and design such systems using classical and modern feedback control techniques, including H. and H2.
3. **AERODYNAMICS:** Be able to use classical analytic, experimental and modern computational techniques of subsonic and supersonic aerodynamics, including laminar and turbulent boundary-layer viscous effects, with or without heat addition, to calculate internal flow properties through inlets, nozzles and engines and external air flow pressure distributions over wings, canards, tails, and other lifting surfaces to determine the resulting lift, drag and pitching moment.
4. **INFORMATION PROCESSING:** Understand the general functional and system architecture of typical military avionics systems, including an understanding of microprocessor interfaces and a knowledge of software design, and be able to use the tools of deterministic and stochastic systems theory to analyze and design basic guidance, navigation and control systems, determining overall stability and performance.
5. **ENGINEERING MATHEMATICS:** Demonstrate analytic ability to apply differential and integral calculus, ordinary and partial differential equations, complex variables, vector calculus, matrix algebra, probability and statistics and numerical analysis in the development of engineering theory and its application to military engineering problems.
6. **ELECTRICAL ENGINEERING:** Understand basic electrical circuits, systems, and electronic devices, microwave communications, signal processing, antenna theory, electro-optics of pulse and continuous beamforming, and infra-red and laser technology as foundational tools for application to design and analysis of military aircraft avionics systems.

7. **SYSTEMS DESIGN:** Be able to integrate the disciplines of aeronautics and electronics into a design of an aircraft avionics system in response to a realistic set of military requirements, specifications, constraints. The design must include considerations for safety, reliability, maintainability and survivability.
8. **JOINT AND MARITIME STRATEGIC PLANNING:** Possess a knowledge of joint and maritime strategic planning to include development and execution of military strategy and the effects of technical developments of warfare; formulation of U.S. policy, roles of military forces, joint planning and current issues in defense reorganization.
9. **RESEARCH, DEVELOPMENT, TEST AND EVALUATION:** Apply principles of project scoping, planning, design and execution to investigate a current research, development, test or evaluation problem of interest to the Department of Defense that culminates in the publication of a thesis of academic quality.

SPECIALIZATION OPTIONS

Listed below are educational skills in four specialization options that may be pursued as advanced topic electives in aeronautical engineering after the core has been completed in the area.

FLIGHT MECHANICS: Obtain experience in flight test and evaluation by means of an in-flight laboratory and/or flight simulators; Be able to analyze aircraft components for the transient load and unsteady aerodynamics of gusts, buffeting and flutter.

INFORMATION PROCESSING: Be able to use modern computer methods in aeronautical engineering analysis; understand data bus architectures, including fiber optic concepts.

ELECTRICAL ENGINEERING: Be able to incorporate digital signal processing techniques to mission relevant applications such as radar systems, electronic warfare, antisubmarine warfare and electro-optic sensors.

SYSTEM DESIGN: Expand design experience over that obtained in the core by executing designs to meet a given set of military mission requirements under realistic constraints in one or more of the following areas: fixed wing aircraft, rotary wing aircraft, tactical missiles and/or aircraft gas turbine engines.

METEOROLOGY AND OCEANOGRAPHY (METOC) PROGRAMS

Curricular Officer:

Thomas D. Lage

CDR, USN

Code 35, Root Hall, Room 216

(408) 656-2044

DSN 878-2044

METEOROLOGY CURRICULUM 372

This curriculum will provide qualified personnel with a sound understanding of the science of meteorology. The student will develop the technical expertise to assess and forecast the impact of atmospheric conditions on operations:

- 1) To understand the science of meteorological data and models.
- 2) To sample/measure, analyze and predict atmospheric conditions.
- 3) To operate and control data/information management systems.
- 4) To plan, conduct, interpret and present results of research activities.

REQUIREMENTS FOR ENTRY

This program is open to International Officers, officers from other services and DoD civilians. It is open to METOC (1800) officers of the U.S. Navy as a Ph.D. program.

A baccalaureate degree with completion of mathematics through differential and integral calculus and a minimum of one year of college physics is required. An APC of 323 is required for direct entry. The Engineering Science Curriculum 460 is available for candidates who do not meet all admission requirements for direct entry.

ENTRY DATES

Meteorology is a seven-quarter course of study with preferred entry dates in April and October. Six-week technical refreshers in calculus, physics and introduction to Meteorology are available preceding the entry dates. For further information contact the Curricular Officer, CDR Thomas D. Lage. Academic questions may be referred directly to the Academic Associate.

Curriculum 372

Academic Associate:

Roger T. Williams, Professor

Code MR/Wu, Root Hall, Room 247

(408)656-2296, DSN 878-2296

DEGREE

Master of Science in Meteorology.

TYPICAL COURSE OF STUDY

Quarter 1

| | | |
|-----------|-------|--|
| MR3480 | (4-1) | Atmospheric Thermodynamics and Radiative Processes |
| MR/OC3140 | (3-2) | Probability and Statistics for Air-Ocean Sciences |
| MA2049 | (3-0) | Vector Analysis |
| MA2121 | (4-0) | Differential Equations |

| | | |
|------------------|-------|--|
| Quarter 2 | | |
| MR/OC3321 | (4-0) | Air-Ocean Fluid Dynamics |
| MR/OC3522 | (4-2) | Remote Sensing of the Atmosphere and Ocean/Laboratory |
| MR/OC3150 | (3-2) | Analysis of Air-Ocean Time Series |
| MA3132 | (4-0) | Partial Differential Equations and Integral Transforms |

| | | |
|------------------|-------|---------------------------------------|
| Quarter 3 | | |
| MR4322 | (4-0) | Dynamic Meteorology |
| MR3222 | (4-3) | Meteorological Analysis/Lab |
| NS3252 | (4-0) | Joint and Maritime Strategic Planning |
| MRXXXX | (3-0) | Meteorology Elective |

| | | |
|------------------|-------|--|
| Quarter 4 | | |
| MR3234 | (4-4) | Tropospheric and Stratospheric Meteorology/Lab |
| MR4900 | (3-0) | Special Topics in Meteorology |
| MR/OC4323 | (4-2) | Numerical Air and Ocean Modeling |

| | | |
|------------------|-------|--------------------------|
| Quarter 5 | | |
| MR3252 | (3-4) | Tropical Meteorology/Lab |
| MR0810 | (0-8) | Thesis Research |
| MRXXXX | (4-0) | Meteorology Elective |
| MRXXXX | (4-0) | Meteorology Elective |

| | | |
|------------------|-------|--|
| Quarter 6 | | |
| MR3262 | (3-5) | Operational Atmospheric Prediction/Lab |
| MR0810 | (0-8) | Thesis Research |
| MR4415 | (3-0) | Air Sea Interaction |
| MRXXXX | (4-0) | Meteorology Elective |

| | | |
|------------------|-------|-----------------------|
| Quarter 7 | | |
| MR0999 | (2-0) | Thesis Presentation |
| MR0810 | (0-8) | Thesis Research |
| MR4241 | (3-0) | Mesoscale Meteorology |
| MRXXXX | (4-0) | Meteorology Elective |

METEOROLOGY AND OCEANOGRAPHY (METOC) CURRICULUM 373

This curriculum in meteorology and oceanography involves approximately 120-quarter hours of classroom lectures, supplemented by an additional 35-quarter hours of laboratory exercises. This program is designed to provide the student with:

- 1) A thorough understanding of the principles governing the physical and dynamic properties of the oceans and atmosphere.
- 2) The ability to observe, assimilate, analyze, interpret, and predict oceanic and atmospheric parameters and conditions using field experimentation, direct and remote sensing observational techniques, statistical analyses and numerical models.
- 3) A thorough understanding of the effects of oceanic and atmospheric properties and conditions on weapon, sensor and platform performance while conducting and supporting Naval warfare with particular emphasis on ocean acoustics and electromagnetic/optical propagation.
- 4) An oceanographic or meteorological research experience germane to Naval warfare culminating in a thesis of professional quality.
- 5) A knowledge of Joint and Maritime Strategic Planning.

This education will enhance performance in all duties throughout a career, including operational billets, technical management assignments and policy making positions. Students will develop graduate-level technical ability based upon scientific principles,

acquire diverse professional knowledge and develop analytical ability for practical problem solving.

REQUIREMENTS FOR ENTRY

This program is open to METOC (1800) Officers, officers from other services, International Officers and DoD Civilians.

A baccalaureate degree in the physical sciences, mathematics or engineering is required. Completion of mathematics through differential and integral calculus and one year of calculus-based college physics are required. An APC of 323 is required for direct entry. The Engineering Science Curriculum 460 is available for candidates who do not meet all admission requirements for direct entry.

METOC SUBSPECIALTY

Completion of this curriculum qualifies an officer as an METOC Subspecialist with a subspecialty code of XX47P. The Curriculum Sponsor is OP-096, Oceanographer of the Navy.

Typical Jobs in this Subspecialty:

METOC Officer: CV/LHD/LHA/LPH

Submarine Group Staff

Fleet Staff

CRUDESGRU Staff

OIC Naval Meteorology and Oceanography Command Detachment

NAVMETOCOM Center/Facility

Defense Mapping Agency

Office of Naval Research

ENTRY DATES

METOC curriculum is a nine-quarter course of study with preferred entry dates in April and October. Six-week technical refreshers in calculus, physics, and Introduction to Meteorology, are available preceding these entry dates. If further information is needed, contact the Curricular Officer. Academic questions may be referred directly to either of the Academic Associates.

Curriculum 373

Academic Associates:

Roger T. Williams, Professor

Code MR/Wu, Root Hall, Room 247

(408) 656-2296 DSN 878-2296

Roland W. Garwood, Jr., Professor

Code OC/Gd, Spanagel Hall, Room 308

(408) 656-3260 DSN 878-3260

DEGREE

Master of Science in Meteorology and Physical Oceanography.

TYPICAL COURSE OF STUDY

Quarter 1

| | | |
|-----------|-------|--|
| MR/OC3140 | (3-2) | Probability and Statistics for Air-Ocean Science |
| MR3480 | (4-1) | Atmospheric Thermodynamics and Radiative Processes |
| MA2049 | (3-0) | Vector Analysis |
| MA2121 | (4-0) | Differential Equations |

Quarter 2

| | | |
|-----------|-------|--------------------------|
| MR/OC3321 | (4-0) | Air-Ocean Fluid Dynamics |
|-----------|-------|--------------------------|

| | | |
|------------------|-------|---|
| MR/OC3522 | (4-2) | Remote Sensing of the Atmosphere and Ocean/ Laboratory |
| OC3230 | (3-1) | Descriptive Physical Oceanography |
| MA3132 | (4-0) | Partial Differential Equations and Integral Transforms |
| Quarter 3 | | |
| MR4322 | (4-0) | Dynamic Meteorology |
| MR3222 | (4-3) | Meteorological Analysis |
| OC3420 | (3-2) | Ocean Dynamics I |
| OC3903 | (3-0) | Fundamentals of MC & G |
| Quarter 4 | | |
| MR/OC3150 | (3-2) | Analysis of Air-Ocean Time Series |
| OC4211 | (4-0) | Ocean Dynamics II |
| MR3234 | (4-4) | Tropospheric and Stratospheric Analysis/Lab |
| Quarter 5 | | |
| MR3252 | (3-4) | Tropical Meteorology |
| MR/OC4413 | (4-1) | Air-Sea Interaction |
| OC3260 | (4-0) | Sound in the Ocean |
| MR/OCXXXX | (3-0) | Coastal Elective |
| Quarter 6 | | |
| OC3212 | (4-0) | Polar Meteorology/Oceanography |
| MR/OC4323 | (4-2) | Numerical Air and Ocean Modelling |
| OC4267 | (4-0) | Ocean Influences in Underwater Acoustics |
| MR/OC4900 | (3-0) | Special Topics in Meteorology/Oceanography |
| Quarter 7 | | |
| MR4416 | (4-0) | Atmospheric Factors in EM and Optical Propagation |
| MR/OC0810 | (0-8) | Thesis Research |
| OC4331 | (4-0) | Mesoscale Ocean Variability |
| MR/OCXXXX | (4-0) | Sponsor Elective |
| Quarter 8 | | |
| OC4335 | (3-2) | Elements of Ocean Prediction |
| MR/OC0810 | (0-8) | Thesis Research |
| NS3252 | (4-0) | Joint and Maritime Strategic Planning Elective |
| MR/OCXXXX | (4-0) | Sponsor Elective |
| Quarter 9 | | |
| MR/OC0810 | (0-0) | Thesis Research |
| MR/OC0999 | (0-8) | Thesis Presentation |
| MR3262 | (3-5) | Operational Atmospheric Prediction |
| MR/OCXXXX | (4-0) | Sponsor Elective |

OPERATIONAL OCEANOGRAPHY CURRICULUM 374

This flexible oceanography curriculum involves approximately 100-quarter hours of classroom lectures, supplemented by an additional 20-quarter hours of laboratory exercises. This program is designed to provide the student with:

- 1) A thorough understanding of the principles governing the physical and dynamic properties of the oceans.
- 2) An understanding of the analysis and prediction of oceanic and atmospheric parameters and conditions using direct and remote sensing observational

techniques, statistical analyses, and numerical models.

- 3) An understanding of the effects of oceanic and atmospheric properties and conditions on weapon, sensor and platform performance while conducting and supporting Naval warfare with particular emphasis on ocean acoustics.
- 4) An educationally significant oceanographic experience at sea.
- 5) An oceanographic or meteorological research experience germane to Naval warfare culminating in a thesis of professional quality.
- 6) A knowledge of Joint Maritime Strategic Planning.

The Operational Oceanography Curriculum has a physical oceanography and ocean acoustics base and is a very flexible program. The student selects a warfare specialization area in antisubmarine warfare, amphibious warfare, mine warfare, anti-air warfare, strike warfare, and special warfare. This program is open to Unrestricted Line (1100, 1110, 1120, 1310, 1320) Officers, officers from other services, International Officers and DoD civilians.

REQUIREMENTS FOR ENTRY

A baccalaureate degree in the physical sciences, mathematics or engineering is desirable. Completion of mathematics through differential and integral calculus and one year of calculus-based college physics are required. An APC of 323 is required for direct entry. The Engineering Science Program (Curriculum 460) is available for candidates who do not meet all admission requirements for direct entry.

OPERATIONAL OCEANOGRAPHY SUBSPECIALTY

Completion of this curriculum qualifies an officer as an Operational Oceanography Subspecialist with a subspecialty code of XX49P. The curriculum sponsor is OP-096, Oceanographer of the Navy.

Typical Jobs in this Subspecialty:

CV ASW Module
CARGRU Staff
ASW Operations Center
Navy Laboratories
Office of Naval Research
Patrol Wing Detachments
Naval Academy Instructor
Defense Mapping Agency
Naval Oceanographic Office

ENTRY DATES

Operational Oceanography is an eight-quarter course of study with preferred entry dates in April and October. Six week technical refresher in calculus, physics, and an Introduction to Meteorology are available preceding the entry dates. If further information is needed, contact the Academic Associate or the Curricular Officer for this curriculum.

Curriculum 374

Academic Associate:

Ching-Sang Chiu, Associate Professor
Code OC/Ci, Root Hall, Room 106D
(408) 656-3239, DSN 878-3239

DEGREE

Master of Science in Physical Oceanography.

TYPICAL COURSE OF STUDY

Quarter 1

| | | |
|-----------|-------|--|
| MR/OC3140 | (3-2) | Probability and Statistics for Air-Ocean Science |
| OC3230 | (3-1) | Descriptive Physical Oceanography |
| MA2049 | (3-0) | Vector Analysis |
| MA2121 | (4-0) | Differential Equations |

Quarter 2

| | | |
|-----------|-------|--|
| MR/OC3150 | (3-2) | Analysis of Air-Ocean Time Series |
| MR/OC3321 | (4-0) | Air-Ocean Fluid Dynamics |
| MA3132 | (4-0) | Partial Differential Equations and Integral Transforms |
| XXXX | (4-0) | Warfare Specialization Course |

Quarter 3

| | | |
|--------|-------|---------------------------------------|
| OC3260 | (4-0) | Sound in the Ocean |
| OC3240 | (4-2) | Ocean Dynamics I |
| OC3120 | (4-2) | Biogeochemical Processes in the Ocean |
| XXXX | (3-0) | Warfare Specialization Course |

Quarter 4

| | | |
|--------|-------|---|
| OC4267 | (4-0) | Ocean Influences in Underwater Acoustics |
| OC4211 | (4-0) | Ocean Dynamics II |
| SS3525 | (4-2) | Air-Ocean Remote Sensing (for Inter-Disciplinary Curricula) |
| XXXX | (3-0) | Warfare Specialization Course |

Quarter 5

| | | |
|-----------|-------|--------------------------------|
| MR/OC4413 | (4-0) | Air-Sea Interaction |
| OC4900 | (3-0) | Special Topics in Oceanography |
| OC4331 | (4-0) | Mesoscale Ocean Variability |
| XXXX | (4-0) | Warfare Specialization Course |

Quarter 6

| | | |
|--------|-------|---------------------------------------|
| NS3252 | (4-0) | Joint and Maritime Strategic Planning |
| OC0810 | (0-8) | Thesis Research |
| OC4335 | (3-2) | Elements of Ocean Prediction |
| XXXX | (4-0) | Warfare Specialization Course |

Quarter 7

| | | |
|--------|-------|------------------------------|
| OC0810 | (0-8) | Thesis Research |
| OC3570 | (2-4) | Operational Oceanography |
| OC4213 | (3-1) | Nearshore and Wave Processes |
| OCXXXX | (4-0) | Elective |

Quarter 8

| | | |
|--------|-------|----------------------|
| OC0810 | (0-8) | Thesis Research |
| OC0999 | (0-0) | Thesis Presentation |
| OC4220 | (4-0) | Coastal Oceanography |
| OCXXXX | (4-0) | Elective |

**OCEANOGRAPHY
CURRICULUM 440**

The Oceanography Curriculum provides students with a sound understanding of the science of oceanography. The student develops the technical expertise to provide and use oceanographic and acoustical data and models in support of all aspects of at-sea operations. The graduate will be able to:

- 1) Interpret and predict oceanic and air-ocean interface conditions.

- 2) Operate modern oceanographic data management, archival and communications systems.
- 3) Plan, conduct, interpret and present results of research activities.

This education further enhances performance in operational billets, technical management assignments and policy making positions. Students will develop sound, graduate-level technical ability based on scientific principles.

REQUIREMENTS FOR ENTRY

This program is open to International Officers, officers from other services and DoD civilians. It is open to METOC (1800) officers as a Ph.D. program.

A baccalaureate degree in the physical sciences, mathematics or engineering is required. Completion of mathematics through differential and integral calculus and one year of calculus-based college physics are required. An APC of 323 is required for direct entry. The Engineering Science Program (Curriculum 460) is available for candidates who do not meet all admission requirements for direct entry.

ENTRY DATES

Oceanography is an eight-quarter course of study with entry dates in April and October. A six-week technical refresher in calculus and physics is available preceding these entry dates. Also available during the refresher is a short course in FORTRAN programming. If further information is needed, contact the Curricular Officer for this curriculum. Academic questions may be referred directly to the Academic Associate.

Curriculum 440

Academic Associate:

Roland W. Garwood, Professor
Code OC/Gd, Spanagel Hall, Room 308
(408)656-3260, DSN 878-3260

DEGREE

Master of Science in Physical Oceanography.

TYPICAL COURSE OF STUDY

Quarter 1

| | | |
|-----------|-------|--|
| MR/OC3140 | (3-2) | Probability and Statistics for Air-Ocean Science |
| OC3230 | (3-1) | Descriptive Physical Oceanography |
| MA2049 | (3-0) | Vector Analysis |
| MA2121 | (4-0) | Differential Equations |

Quarter 2

| | | |
|-----------|-------|---|
| MR/OC3321 | (4-0) | Air-Ocean Fluid Dynamics |
| MR/OC3522 | (4-2) | Remote Sensing of the Atmosphere and Ocean/ Laboratory |
| MA3132 | (4-0) | Partial Differential Equations and Integral Transforms |
| OCXXXX | (3-0) | Oceanography Elective |

Quarter 3

| | | |
|--------|-------|---------------------------------------|
| OC3260 | (4-0) | Sound in the Ocean |
| OC3240 | (3-2) | Ocean Dynamics I |
| OCXXXX | (3-0) | Oceanography Elective |
| OC3120 | (4-2) | Biogeochemical Processes in the Ocean |

| | | |
|------------------|-------|-----------------------------------|
| Quarter 4 | | |
| OC4211 | (4-0) | Ocean Dynamics II |
| MR/OC3150 | (3-2) | Analysis of Air-Ocean Time Series |
| OC4267 | (4-0) | Ocean Acoustic Prediction |
| OCXXXX | (4-0) | Oceanography Elective |
| Quarter 5 | | |
| MR/OC4413 | (4-1) | Air-Sea Interaction |
| OC4900 | (3-0) | Special Topics in Oceanography |
| OC3570 | (2-4) | Operational Oceanography |
| OC4331 | (4-0) | Mesoscale Ocean Variability |
| Quarter 6 | | |
| OC3212 | (4-0) | Polar Meteorology/Oceanography |
| MR/OC4323 | (4-2) | Numerical Air and Ocean Modelling |
| MR/OC4414 | (3-0) | Advanced Air-Sea Interaction |
| OC0810 | (0-8) | Thesis Research |
| Quarter 7 | | |
| OC4213 | (3-1) | Nearshore and Wave Processes |
| OCXXXX | (4-0) | Oceanography Elective |
| OC0810 | (0-8) | Thesis Research |
| OC4220 | (3-0) | Coastal Oceanography |
| Quarter 8 | | |
| OC4220 | (3-2) | Elements of Ocean Prediction |
| OCXXXX | (4-0) | Oceanography Elective |
| OC0810 | (0-8) | Thesis Research |
| OC0999 | (0-0) | Thesis Presentation |

**EDUCATIONAL SKILL REQUIREMENTS
METOC
CURRICULUM(373)**

1. The officer must have a thorough understanding of the principles governing the physical and dynamic properties of the oceans and atmosphere.
2. The officer must have the ability to observe, assimilate, analyze, interpret and predict oceanic and atmospheric parameters and conditions using field experimentation, direct and remote sensing observational techniques, statistical analysis and numerical models.
3. The officer must have a thorough understanding of the effects of oceanic, and atmospheric properties and conditions on weapon, sensor and platform performance while conducting and supporting Naval warfare with particular emphasis on oceanic acoustics and electromagnetic and optical propagation.
4. The officer must have a knowledge of Joint and Maritime Strategic planning to include development and execution of military strategy and the effects of technical developments on warfare; formulation of U.S. policy, roles of military forces, Joint planning, and current issues in Defense reorganization.
5. The officer must have a thorough understanding of the fundamentals of Mapping, Charting and Geodesy (MC&G), precise time and time interval (PTTI), and astrometry.
6. The officer must successfully complete all requirements for the Joint Masters Degree in Meteorology and Physical Oceanography.

**EDUCATIONAL SKILL REQUIREMENTS
OPERATIONAL OCEANOGRAPHY
CURRICULUM (374)**

1. The officer must have a thorough understanding of the principles governing the physical and dynamic properties of the oceans and atmosphere.
2. The officer must have the ability to observe, assimilate, analyze, interpret and predict oceanic and littoral water conditions using field experimentation, direct and remote sensing observational techniques, statistical analysis and numerical models.
3. The officer must have an understanding of the effects of oceanic, littoral and atmospheric properties and conditions on weapons, sensor and platform performance while conducting and supporting Naval Warfare with particular emphasis on ocean acoustics.
4. The officer must have a knowledge of Joint and Maritime Strategic planning to include development and execution of military strategy and the effects of technical developments on warfare; formulation of U.S. policy, roles of military forces, Joint planning, and current issues in Defense reorganization.
5. The officer must successfully complete all NPS requirements for the Masters Degree in Physical Oceanography.

COMBAT SYSTEMS PROGRAMS

Curricular Officer:

M. Witt

CDR, USN

Code 33, Spanagel Hall

Room 200

(408)656-2116/7DSN 878-2116/7

COMBAT SYSTEMS SCIENCES AND TECHNOLOGY CURRICULUM 533

This program is designed to meet the needs of the military services for an officer having a broad-based advanced technical education applicable to combat systems design, development, test and evaluation, acquisition, operation, and support. Included in the core are courses on electromagnetic radiation, signal processing, optoelectronics, servo and computer control systems, explosives and warheads, fluid dynamics of weapons, mine warfare, engineering materials, combat simulation, quantum detection devices, detection and engagement elements, combat systems integration, and computers for advanced combat systems. Additionally, the officer will take a sequence of five or more courses in one of the following concentration areas: electromagnetic sensors systems, nuclear and directed energy weapons and effects, underwater acoustic systems, or an engineering area related to combat systems. The officer will also conduct thesis research on a specific technical problem. The curriculum includes survey courses in areas not covered by the officer's concentration.

REQUIREMENTS FOR ENTRY

A baccalaureate degree with mathematics through differential and integral calculus and a calculus-based basic physics sequence are required for direct input. Courses in the physical sciences and engineering are highly desirable. Officers not having the required qualifications for direct input enter the program indirectly through the Engineering Science (460) Curriculum discussed elsewhere in this catalog. An APC of 323 is required.

COMBAT SYSTEMS SCIENCES AND TECHNOLOGY SUBSPECIALTY

Completion of this curriculum qualifies an officer as a Combat Systems Sciences and Technology Subspecialist with a subspecialty code of XX66P. The curriculum sponsors are Naval Sea Systems Command and the Space and Naval Warfare Command.

Typical Jobs in this Subspecialty:

NTDS-CIC: FLTCOMBDSSA, San Diego, CA

Warfare Systems Officer: SPAWAR OPSUPFLD 6

Weapons Instructor: Naval Academy, Annapolis, MD

Staff Readiness (Weapons): COMCRUDESGRU 1, 2, 3, 5, 8, 12

Testing Officer: COMOPTEVFOR

Weapons Instructor: SWOSCOLCOM

Weapons Department Head: Naval Academy, Annapolis, MD

Research Associate: Lawrence Livermore Laboratory

Physics Instructor: Naval Academy, Annapolis, MD

Research Associate: Los Alamos National Laboratory

Electro-Optics Project Officer: Naval Ocean Systems Center, San Diego CA

Testing Officer: COMOPTEVFOR

Research Officer: Naval Research Laboratory

Project Management: Naval Sea Systems Command

Test Manager: Defense Nuclear Agency (DNA)

Research and Development Coordinator: Defense Nuclear Agency (DNA)
 Physicist: Defense Nuclear Agency (DNA) Tactical Nuclear Weapons/Plans: CINCLANT
 Test Officer/Programs Officer: DNA, Kirkland AFB
 Navy Research Officer: Los Alamos National Laboratory
 Navy Research Officer: Lawrence Livermore Laboratory
 Nuclear Effects Officer/Nucleonics Officer: SPAWARSYSCOM
 Nuclear Physicist: DNA, Los Alamos
 Instructor: Nuclear Weapons Training Group - Atlantic
 Instructor: Naval Postgraduate School, Monterey, CA
 Training Officer: PDW-124 (Undersea Surveillance)
 Staff: Commander 7th Fleet
 Staff: COMNAVSURFLANT
 Test and Evaluation Officer: OPTEVFOR
 Strategic Systems Project Officer: Director of SSPO
 Staff Antisubmarine Warfare: NAVSEASYSKOM
 Research and Development Project Officer: Office of Secretary of Defense

ENTRY DATES

Combat Systems Sciences and Technology is a nine-quarter course of study with entry dates in April and October. If further information is needed, contact the Academic Associate or Curricular Officer for this curriculum. Other entry dates are possible by special arrangement with the curricular officer.

Curriculum 533

Academic Associate:

James V. Sanders, Associate Professor
 Code PH/Sd, Spanagel Hall, Room 200
 (408) 656-3884/2116, DSN 878-3884/2116

DEGREE

Requirements for the degree Master of Science in Applied Physics are met as a milestone en route to satisfying the Educational Skill Requirements of the curricular program. On a case-by-case basis, some students, depending on background, may earn a Master of Science in Physics, Computer Science or one of the engineering disciplines.

TYPICAL COURSE OF STUDY

Quarter 1

| | | |
|--------|-------|-------------------------------------|
| MA1118 | (5-2) | Multi-variable Calculus |
| MA2121 | (4-0) | Differential Equations |
| PH2151 | (4-1) | Particle Mechanics |
| SE2012 | (2-3) | Applied Physics Lab I: Fundamentals |

Quarter 2

| | | |
|--------|-------|---|
| PH2911 | (3-2) | Introduction to Computational Physics |
| PH2351 | (4-1) | Electromagnetism |
| PH3991 | (4-0) | Physics of Oscillations & Waves I |
| SE2013 | (2-3) | Applied Physics Lab II: Analog Techniques |

Quarter 3

| | | |
|--------|-------|---|
| PH3152 | (4-0) | Extended Systems |
| PH3352 | (4-1) | Electromagnetic Waves and Propagation |
| PH3652 | (4-1) | Foundations of Quantum Devices |
| SE2014 | (2-3) | Applied Physics Lab III: Digital Techniques |

Quarter 4

| | | |
|--------|-------|---|
| MS2201 | (3-2) | Engineering Materials |
| PH3653 | (4-0) | Quantum Devices |
| PH3292 | (3-2) | Optics and Optoelectronics |
| SE3015 | (2-3) | Applied Physics Lab IV: Systems Control |

Quarter 5

| | | |
|--------|-------|---|
| MS3202 | (3-2) | Failure Analysis |
| PH3172 | (4-0) | Fluid Dynamics of Weapons |
| PH4050 | (4-2) | Sensors and Devices |
| PH4911 | (3-2) | Simulation of Physical & Weapon Systems |

Quarter 6

| | | |
|--------|-------|---------------------------------------|
| | | Concentration Course |
| NS3252 | (4-0) | Joint and Maritime Strategic Planning |
| PH3171 | (4-0) | Explosives and Explosions |
| PH3400 | (4-2) | Underwater Acoustics |

Quarter 7

| | | |
|--------|-------|------------------------------------|
| | | Concentration Course |
| | | Concentration Course |
| XX0810 | (0-8) | Thesis Research |
| EO3816 | (4-0) | Combat Systems Integration Project |

Quarter 8

| | | |
|--------|-------|---|
| | | Concentration Course |
| | | Concentration Course |
| XX0810 | (0-8) | Thesis |
| EO4980 | (3-0) | Computer Architecture for Military Applications |
| PH3400 | (4-2) | Survey of Underwater Acoustics |

Quarter 9

| | | |
|--------|-------|----------------------|
| | | Concentration Course |
| | | Concentration Course |
| XX0810 | (0-8) | Thesis Research |
| XX0810 | (0-8) | Thesis Research |

Concentration Area and Representative Courses**Electromagnetic Sensor Systems:**

Thermodynamics & Statistical Physics; Advanced Electromagnetic Propagation; Sensors and Devices; Advanced Concepts in Target Surveillance, Acquisition, & Engagement; Sensors, Signal & Systems; Thermal Imaging & Surveillance Systems; Directed Energy Weapon Systems; Free Electron Lasers; Plasma Physics; Space Environment.

Weapons and Effects:

Nuclear Physics; Directed Energy Weapon Systems; Nuclear Weapons Survivability & Lethality; Physics of High Velocity Impact; Physics of Nuclear Explosions; Weapons Proliferation and Control.

Underwater Acoustic Systems:

Fundamental Acoustics; Underwater Acoustics; Transducer Theory and Design; Noise, Shock & Vibration Control; Sound Propagation in the Ocean; Sonar Signal Processing.

**EDUCATIONAL SKILL REQUIREMENTS
COMBAT SYSTEMS SCIENCE AND TECHNOLOGY
CURRICULUM (533)**

- 1. MATHEMATICS, SCIENCE, AND ENGINEERING FUNDAMENTALS:** A solid foundation in mathematics, physics, and engineering underpinning combat-systems technology to support the theoretical and experimental aspects of the technical courses in the curriculum.
- 2. SCIENTIFIC AND ENGINEERING PRINCIPLES** necessary to understand the elements of combat systems:
 - a. Acoustic and electromagnetic propagation; physics of solid-state, electro-optic, and quantum devices; principles of radar and sonar systems; and signal analysis and decision theory.
 - b. Communication systems, fiber optics, open architectures and their implications on integration of computing resources in advanced combat systems, and automatic control systems.
 - c. Fluid dynamics of subsonic and supersonic weapons, warheads and their effects (nuclear and conventional), counter measures and deception techniques.
 - d. Combat systems simulation and testing including sufficient probability and statistics theory to appreciate the limits of simulation.
- 3. COMBAT SYSTEMS ENGINEERING:** An understanding of the principles of design, development, improvement, and logistics engineering; and the importance of technical and economic trade-offs in combat systems.
- 4. MATERIALS SCIENCE:** A familiarity of the concepts of materials science sufficient for an understanding of the mechanical, electrical, and thermal properties of materials important in present and future combat systems.
- 5. JOINT AND MARITIME STRATEGIC PLANNING:** American and world military history and joint and maritime planning including the origins and evolution of national and allied strategy; current American and allied military strategies which address the entire spectrum of conflict; the U.S. maritime component of national military strategy; the organizational structure of the U.S. defense establishment; the role of the commanders of unified and specified commands in strategic planning, the process of strategic planning; joint and service doctrine, and the roles and missions of each in meeting national strategy.
- 6. GRADUATE CONCENTRATION:** A concentration of several graduate-level courses in a technical field within the general area of combat systems. The knowledge required for an approved concentration is:

A. ELECTROMAGNETIC SYSTEMS

- 1) Propagation and scattering of optical and microwave radiation in the turbulent atmosphere as they influence target detection.
- 2) Advanced sensor and detection techniques for military applications.
- 3) Advanced concepts of target surveillance, acquisition, and engagement.

B. WEAPONS & EFFECTS

- 1) Nuclear and statistical physics
- 2) Nuclear weapons and their effects.
- 3) Effects of radiation & EMP on electronic systems.
- 4) Principles of directed energy weapons systems and their effects.
- 5) Survivability & lethality considerations for conventional, nuclear, biological and chemical weapons.

C. UNDERWATER ACOUSTIC SYSTEMS

- 1) Wave propagation in the ocean; scattering, fluctuations and boundary interactions as they effect detection, localization, and prosecution of underwater targets; underwater transducer design and array theory.
- 2) Active and passive acoustic signal processing for detection of submarines, mines, and other underwater weapons; adaptive techniques.
- 3) Acoustic influences of oceanographic phenomena which effect target detection including boundary characteristics, ambient noise, sound speed profiles, fronts, and eddies.

D. ENGINEERING DISCIPLINE:

A series of at least five graduate-level courses in an area related to combat systems in the disciplines of either Engineering, Computer Science, or Physics. This series must be approved by the Curricular Officer.

7. A survey course in each of the above concentration areas not covered in the officer's individual program.
8. **THESIS:** The graduate will demonstrate the ability to conduct independent analysis in combat systems science and technology and proficiency in presenting the results in writing and orally by means of a thesis and command-oriented briefing.

ELECTRONICS AND COMPUTER PROGRAMS

Curricular Officer:

Bob Ellis
CDR, USN
Code 32, Spanagel Hall
Room 404
(408) 656-4660/4679
DSN 878-4660/4679
FAX 656-3681
email: bellis@nps.navy.mil

COMPUTER SCIENCE CURRICULUM 368

The Computer Science curriculum is designed to provide the officer with the technical knowledge and skills necessary to specify, evaluate and manage computer system design; to provide technical guidance in applications ranging from data processing to tactical embedded systems; to educate the officer in the analysis and design methodologies appropriate for hardware, software and firmware; and to provide the officer with practical experience in applying modern computer equipment and research techniques to solve military problems.

REQUIREMENTS FOR ENTRY

A baccalaureate degree, or the equivalent, with above-average grades in mathematics, (including differential and integral calculus) resulting in an APC of at least 325 is required for direct entry. Undergraduate degrees in applied science or engineering are highly desirable. Students lacking these prerequisites may be acceptable for the program, through a six or twelve week refresher, providing their undergraduate records and/or other indicators of success, such as the GRE (Graduate Record Examination), indicate a capability to work in quantitative subjects. While previous academic or practical experience in computer science is certainly helpful and can enhance the applicant's potential for admission, such experience is not a prerequisite.

COMPUTER SCIENCE SUBSPECIALTY

Completion of this curriculum qualifies an officer as a Computer Science Subspecialist with a subspecialty code of XX91P. The Curriculum Sponsor is Commander, Naval Computer and Telecommunications Command.

Typical Jobs in this Subspecialty:

Operational Test and Evaluation, Space and Electronic Warfare
Systems Command, Washington, DC
Computer Systems Analyst, COMNAVSECGRU, Washington, DC
DP Systems Director, Naval Security Group Honolulu, HI
Database Manager, TACTRAGRUPAC, San Diego, CA
Project Officer, BUPERS, Washington, DC

ENTRY DATES

Computer Science is an eight-quarter course of study with entry dates in April and October. Those requiring the six or twelve week refresher will begin study prior to those entry dates. If further information is needed, contact the Academic Associate or Curricular Officer for this curriculum.

Curriculum 368

Academic Associate:

Michael Zyda, Professor
Code CS/Zk, Spanagel Hall, Room 516
(408) 656-2305, DSN 878-2305
Fax: (408) 656-2814, DSN 878-2814
Email: zyda@trouble.cs.nps.navy.mil

Requirements for the degree Master of Science in Computer Science are met as a milestone en route to satisfying the Educational Skill Requirements established by the sponsor for the curricular program.

TYPICAL COURSE OF STUDY

Quarter 1

| | | |
|--------|-------|---|
| CS2970 | (4-1) | Structured Programming in ADA |
| CS3010 | (4-0) | Computing Devices and Systems |
| MA2025 | (4-1) | Bridge to Advanced Mathematics |
| OS3001 | (4-0) | Operations Research for Computer Scientists |

Quarter 2

| | | |
|--------|-------|--|
| CS3111 | (4-0) | Principles of Programming Languages |
| CS3200 | (3-2) | Computer Architecture |
| CS3300 | (3-1) | Data Structures |
| MA3026 | (5-0) | Discrete Mathematics with Applications |

Quarter 3

| | | |
|--------|-------|-------------------------|
| CS3310 | (4-0) | Artificial Intelligence |
| CS3320 | (3-1) | Database Systems |
| CS3450 | (3-2) | Operating Systems |
| CS3460 | (3-1) | Software Methodology |

Quarter 4

| | | |
|--------|-------|---|
| CS3502 | (4-0) | Computer Communications and Networks |
| CS3601 | (4-0) | Theory of Formal Languages and Automata |
| CS4900 | (0-2) | Research Seminar in Computer Science |
| ----- | (4-0) | Track Requirement* |
| ----- | (4-0) | Track Requirement* |

Quarter 5

| | | |
|--------|-------|-------------------------------|
| CS4112 | (3-2) | Distributed Operating Systems |
| CS4202 | (3-2) | Computer Graphics |
| CS4601 | (4-0) | Computer Security |
| ----- | (4-0) | Track Requirement* |

Quarter 6

| | | |
|--------|-------|-----------------------------------|
| CS3650 | (4-0) | Design and Analysis of Algorithms |
| ----- | (4-0) | Track Requirement* |
| ----- | (4-0) | Track Requirement* |
| CS0810 | (0-8) | Thesis Research |

Quarter 7

| | | |
|--------|-------|---------------------------------------|
| ----- | (4-0) | Track Requirement* |
| ----- | (4-0) | Track Requirement* |
| NS3252 | (4-0) | Joint and Maritime Strategic Planning |
| CS0810 | (0-8) | Thesis Research |

Quarter 8

| | | |
|--------|-------|--------------------|
| ----- | (4-0) | Track Requirement* |
| ----- | (4-0) | Track Requirement* |
| CS0810 | (0-8) | Thesis Research |

*NOTE: Track Requirement courses will be determined by the selection of one of the following specialization track options: Artificial Intelligence and Robotics, Computer Graphics and Visual Simulation, Database and Data Engineering, Software Engineering or Computer Systems and Architectures or Computer Systems and Security.

The objectives of the Artificial Intelligence and Robotics Track are to present current state of knowledge regarding advanced symbolic computation, to develop skills in the use of AI languages and expert system shells and to present fundamental scientific/engineering knowledge in robotics for military applications.

The Computer Graphics and Visual Simulation Track is designed to provide an understanding of the methodologies and techniques required in real-time, three-dimensional, interactive, visual simulations for military applications.

The objective of the Database and Data Engineering Track is to provide an understanding of data retrieval and processing using the best available database system management and operating system techniques and concepts.

The purposes of the Software Engineering Track are to provide knowledge of all aspects of software development and to develop skills needed to efficiently and reliably implement military systems and application software using the best available tools and techniques, with particular emphasis on the use of Ada.

The Computer Systems and Architectures Track is designed to provide knowledge of computer architecture and system software for real-time and multi-computer systems with emphasis on military applications to embedded computers and secure systems.

The Computer Systems and Security Track is designed to provide knowledge in all areas of Information Security (INFOSEC) and to develop the necessary skills for those who will be involved in development, evolution or implementation of secure computer systems.

ELECTRONIC SYSTEMS ENGINEERING CURRICULUM 590

This curriculum is designed to educate officers in current electronics technology and its application to modern naval warfare. It establishes a broad background of basic engineering knowledge, leading to selected advanced studies in electronic systems, ship/weapon control systems, and communication/ information processing applicability. It will enhance individual performance in all duties through a naval career, including operational billets, technical management assignments and policy making positions, thereby preparing the officer for progressively increased responsibility including command, both ashore and afloat.

REQUIREMENTS FOR ENTRY

A baccalaureate degree in engineering or the physical sciences is desired. Differential and integral calculus, one year of calculus-based college physics and at least one semester of college chemistry are required. The Engineering Science Program (Curriculum 460) is available for candidates who do not meet all admission requirements. The additional time required will vary with the candidate's background. Prior to undertaking the program, or as a part of the program, each officer will have earned the equivalent of an accredited BSEE. An APC of 323 is required for direct entry.

ELECTRONICS AND COMMUNICATIONS SUBSPECIALTY

Completion of this curriculum qualifies an officer as an Engineering Electronics Subspecialist with a subspecialty code XX55. The curriculum sponsor is Space and Naval Warfare Systems Command.

Typical Jobs in this Subspecialty:

Instructor: Naval Academy, Annapolis, MD

Executive Officer: SPAWARHDQTRS

Operations Test and Evaluation: COMOPTEVFOR

Electronics Maintenance Officer: USS NIMITZ CVN 68

Executive Officer: NEEACT PAC, Pearl Harbor, HI

Electronics P and P: CINCLANTFLT

Electronics Maintenance Officer: USS BLUE RIDGE LCC 19

Project Officer: Warfare Systems Architecture and Engineering, SPAWARHDQTRS

ENTRY DATES

Electronic Systems Engineering is an eight-quarter course of study with entry dates in every quarter. A six-quarter program is available for officers with an ABET accredited BSEE degree on a case-by-case basis. If further information is needed, contact the Academic Associate or the Curricular Officer.

Curriculum 590**Academic Associate:**

Clark Robertson, Professor

Code EC/Rc, S-414A

(408)656-2383, DSN 878-2383

e-mail: crobertson@nps.navy.mil

DEGREE

Requirements for the degree Master of Science in Electrical Engineering are met en route to satisfying the Educational Skill Requirements.

TYPICAL COURSE OF STUDY**COMPUTER SYSTEMS OPTION****Quarter 1**

| | | |
|--------|-------|---------------------------------|
| EC2100 | (3-2) | Circuit Analysis I |
| EC2820 | (3-2) | Digital Logic Circuits |
| MA1118 | (5-2) | Multivariable Calculus |
| CS2970 | (4-1) | Structured Programming with Ada |

Quarter 2

| | | |
|--------|-------|---------------------------|
| EC2110 | (3-2) | Circuit Analysis II |
| EC2200 | (3-3) | Electronics Engineering I |
| EC2400 | (3-0) | Discrete Systems |
| EC2800 | (3-2) | Intro to Microprocessors |

Quarter 3

| | | |
|--------|-------|---|
| ECXXXX | | BSEE Elective I |
| EC2210 | (3-2) | Electronics Engineering II |
| EC2410 | (3-0) | Fourier Analysis of Signals and Systems |
| EC3800 | (3-2) | Microprocessor Systems |

Quarter 4

| | | |
|--------|-------|----------------------------|
| ECXXXX | | BSEE Elective II |
| MA3132 | (4-1) | Numerical Analysis |
| EC3500 | (4-0) | Analysis of Random Signals |
| EC2420 | (3-0) | Systems Theory |

Quarter 5

| | | |
|--------|-------|-----------------------------|
| NS3252 | (4-0) | Joint Strategy |
| EC2220 | (2-4) | Electronics Engineering III |
| EC3820 | (3-1) | Computer Systems |
| ECXXXX | | BSEE Elective III |

Quarter 6

| | | |
|--------|-------|-------------------------------------|
| EC3550 | (3-1) | Fiber Optics |
| EC4830 | (3-1) | Digital Computer Design Methodology |
| EC3830 | (3-2) | Digital Computer Design |
| EC0810 | (0-8) | Thesis Research |

Quarter 7

| | | |
|--------|-------|-----------------|
| ECXXXX | | MSEE Elective I |
| EC3850 | (3-0) | Computer Comms |
| EC0810 | (0-8) | Thesis Research |
| EC0810 | (0-8) | Thesis Research |

Quarter 8

| | | |
|--------|-------|------------------------------|
| ECXXXX | | MSEE Elective II |
| EC4800 | (3-0) | Advanced topics in Computers |
| EC4870 | (3-2) | VLSI Systems Design |
| EC0810 | (0-8) | Thesis Research |

EDUCATIONAL SKILL REQUIREMENTS COMPUTER SCIENCE CURRICULUM (368)

1. The officer will have a thorough knowledge of software engineering to include:
 - a. An understanding of the software development process, including specification of requirements, design, implementation, testing and maintenance. Military real time software projects, such as control software for a ship's boiler. Design on systems that emulate requirements in real time embedded systems used by DoD.
 - b. The ability to plan and implement a major programming project and develop the appropriate documentation.
 - c. The ability to incorporate modern software engineering techniques in Ada based systems.
2. The officer must have a thorough knowledge of software technology to include:
 - a. The formal definition of programming languages covering specifications of syntax and semantics, properties of block structured languages, programming techniques and evaluation of languages.
 - b. The relations that hold among the elements of data involved in problems, the structure of storage media and machines, the methods useful in representing structured data in storage, and techniques of operating upon data structures.
 - c. Operating systems used in various environments relative to addressing techniques, memory management, file system design and management, system accountability and security, all built around DoD ADP security instructions.
 - d. The techniques used in the design and implementation of programming languages.
 - e. Design and implementation of database systems including hierarchy, network and relational models, and the language extensions required to support such systems.
 - f. Computer graphics covering human-computer interaction and methods for computer-assisted problem solving.
 - g. Artificial intelligence techniques including heuristic search, artificial intelligence languages, knowledge representation, expert systems and means-end analysis.
 - h. Formal methods for the design and analysis of software systems.

3. The officer must have a thorough knowledge of computer system design to include:
 - a. System analysis and design theory encompassing the basics of analysis, design and testing.
 - b. Empirical and analytical methods for determining the efficiency and performance of computer systems.
 - c. An understanding of the design issues of hardware/software compatibility, operating system compatibility and information system requirements.
 - d. Computer science theory relevant to the capabilities and limitations of hardware and software systems.
 - e. Computer security of DoD and other hardware systems, software systems and networks.
4. The officer must have a thorough knowledge of computer architecture to include:
 - a. Basic components of computer systems and their patterns of configuration and communication covering the range of large scale mainframes to microcomputers.
 - b. The organization, logic design, and components of military and other digital computing systems relating to multiprocessing, multiprogramming, distributed processing and networking.
5. The officer shall possess skills that perform a realistic perspective on solving military and real world problems.
 - a. Completing a significant project applying academic skills outside the classroom.
 - b. The graduate will demonstrate the ability to conduct independent analysis in computer science and proficiency in presenting the results in writing and orally by means of a thesis and command-oriented briefing.
6. American and world military history and joint and maritime planning including the origins and evolution of national and allied strategy; current American and allied military strategies which address the entire spectrum of conflict; the U.S. maritime component of national military strategy; the organizational structure of the U.S. defense establishment; the role of the commanders of unified and specified commands in strategic planning, the process of strategic planning; joint and service doctrine, and the roles and missions of each in meeting national strategy.

EDUCATIONAL SKILL REQUIREMENTS ELECTRONIC SYSTEMS ENGINEERING CURRICULUM (590)

- 1. MATHEMATICS:** The officer will have a thorough knowledge of mathematical tools which are intrinsic to electrical and computer engineering, including, but not limited to differential equations, vector analysis, linear algebra, probability, numerical analysis, and Fourier and Laplace methods.
- 2. ENGINEERING SCIENCE AND DESIGN:** To acquire the requisite background needed to meet the other military education requirements, the officer will acquire proficiency in modern physics, electromagnetics, electronic devices and circuits, system theory, and modern electronic system design; also in other appropriate fields such as underwater acoustics, dynamics, fluid mechanics and thermo- dynamics which provide the requisite breadth to a military engineering education.
- 3. COMPUTERS:** The officer will have a sound understanding of computer hardware, software, and their integration into military systems including programming in higher order languages, digital logic circuits, and microprocessor applications.
- 4. ELECTRONIC AND ELECTRICAL ENGINEERING:** In order to provide officers skilled in the application of electronic systems to military needs, the officer will have competence in the broad area of electrical engineering including circuits, electronics, fiber optics, computer communications networks, and systems analysis. The officer will select elective courses to obtain breadth in his/her understanding of military electronic systems. Additionally, to achieve depth of understanding, the officer shall specialize in one of the following areas: (a) communication systems as applied to electronic counter-counter measures, low probability of intercept systems, low probability of detection systems, and other military issues; (b) guidance, navigation, and control systems; (c) radar, electro-optic, and electronic warfare systems; (d) high performance computer systems including advanced integrated circuits parallel and distributed systems, and reliable real time military platforms; (e) signal processing systems as applied to surveillance, underwater acoustic data acquisition and processing, imaging and target location, and other military issues; (f) total ship systems power engineering.
- 5. SYSTEM DESIGN AND SYNTHESIS:** the officer will have a sound understanding of engineering principles utilized in engineering system design, particularly as they relate to military systems, including establishment of system related objectives and criteria.

6. CONDUCTING AND REPORTING INDEPENDENT

INVESTIGATION: The officer will demonstrate the ability to conduct independent investigation of a Navy and/or DoD relevant electronic systems problem, to resolve the problem, and to present the results of the analysis in both written and oral form.

7. JOINT AND MARITIME STRATEGIC PLANNING: American and world military history and joint and maritime planning including the origins and evolution of national and allied strategy; current American and allied military strategies which address the entire spectrum of conflict; the U.S. maritime component of national military strategy; the organizational structure of the U.S. defense establishment; the role of the commanders of unified and specified commands in strategic planning; the process of strategic planning; joint and service doctrine, and the roles and missions of each in meeting national strategy.

JOINT COMMAND, CONTROL AND COMMUNICATIONS (C3) PROGRAMS

Curricular Officer:

Ernest K. Beran
LTCOL, USAF
Code 39, Root Hall
Room 103H
(408) 656-2772
DSN 878-2772

JOINT COMMAND, CONTROL AND COMMUNICATIONS (C3) CURRICULUM 365

The Joint C3 curriculum is designed to meet broad educational objectives endorsed by the Joint Chiefs of Staff. The overall objective is to provide officers and DoD civilian equivalents, through graduate education, with a comprehensive operational and technical understanding of the field of Command, Control and Communications systems as applied to joint and combined military operations at the national and unified command levels. The program is designed with the following goals: enable individuals to develop an understanding of the role C3 systems play in the use of military power and the ability to interpret the impact of C3 on operating philosophy; provide adequate background knowledge in basic technology, human capabilities and joint military operations and how these factors are exploited in current C3 systems; and, provide the framework whereby students can perform requirement and planning studies of new C3 systems and contribute to crisis management.

These officers should be able to undertake a wide range of assignments in C3 (both joint and intra-service) over the full span of their careers.

REQUIREMENTS FOR ENTRY

The Joint C3 curriculum is open to all U.S. Military Services and selected civilian employees of the U.S. Federal Government. Admission requires a baccalaureate degree with above-average grades and mathematics through differential and integral calculus. A TOP SECRET security clearance is required with SPECIAL INTELLIGENCE (SI) clearance obtainable. An APC of 324 is required for direct entry. Officers not meeting the academic requirements for direct input may enter the program via one or two quarters of Engineering Science (Curriculum 460).

JOINT COMMAND, CONTROL AND COMMUNICATIONS (C3) SUBSPECIALTY

Completion of this curriculum qualifies an officer as a Joint Command, Control and Communications (C3) Subspecialist with a subspecialty code of XX45P. The curriculum sponsor is the Directorate for Command, Control and Communications Systems (J6), Joint Staff.

Typical Jobs in this Subspecialty:

Staff Command and Control Officer: Commander in Chief, Pacific Fleet
Surface Systems Officer: Naval Ocean Systems Center
ADP Plans Officer: World Wide Military Command and Control
System Joint Program Office
Staff Operations Plans Officer: Headquarters, European Command
Staff Operations and Plans Officer: Commander 7th Fleet
Programs Manager: Naval Space and Warfare Systems Command

ENTRY DATES

Joint Command, Control and Communications (C3) is a seven-quarter course of study with a single entry date in October. If further information is needed, contact the Academic Associate or the Curricular Officer for this curriculum.

Curriculum 365

Academic Associate:

Dan C. Boger, Professor

Code SM/Bo, Ingersoll Hall, Room 241

(408) 656-2607, DSN 878-2607.

DEGREE

Requirements for the degree Master of Science in Systems Technology [Joint Command, Control and Communications (C3)] are met as a milestone en route to satisfying the Educational Skill Requirements of the curricular program.

TYPICAL COURSE OF STUDY

Quarter 1

| | | |
|--------|-------|-------------------------------------|
| CC3000 | (4-0) | Introduction to C3 |
| OS3404 | (3-2) | Man-Machine Interaction |
| MA1118 | (5-2) | Multi-variable Calculus |
| NS3252 | (4-0) | Joint & Maritime Strategic Planning |

Quarter 2

| | | |
|--------|-------|--|
| CC3101 | (4-0) | Combat Analysis for C3 |
| OS2103 | (4-1) | Applied Probability |
| CS3030 | (4-0) | Computer Architecture and Operating Systems |
| EO2413 | (4-2) | Introduction to Communication System Engineering |

Quarter 3

| | | |
|--------|-------|---|
| CS3020 | (4-0) | Software Engineering to Government Standards |
| EO2503 | (4-2) | Communication Systems Engineering: Modulation |
| OS3008 | (4-0) | Analytical Planning Methodology |
| OS3604 | (4-0) | Decision and Data Analysis |

Quarter 4

| | | |
|--------|-------|--|
| CC4101 | (4-2) | C3 System Engineering |
| OS3603 | (3-1) | Simulation and Wargaming |
| IS4320 | (4-0) | Database System and Information Management |
| EO3503 | (4-2) | Communication System Analysis |

Quarter 5

| | | |
|--------|-------|---|
| CC4103 | (2-4) | C3 Systems Evaluation |
| IS3502 | (4-0) | Computer Networks Emphasis Elective |
| MN3301 | (4-0) | System Acquisition and Project Management |

Quarter 6

| | | |
|--------|-------|--|
| CC4750 | (4-0) | Military C3 Systems and Networks |
| CC0810 | (0-8) | Thesis |
| PH3052 | (4-0) | Space and Airborne Sensing Systems Emphasis Elective |

Quarter 7

| | | |
|--------|-------|-----------------------------|
| CC0810 | (0-8) | Thesis |
| CC0810 | (0-8) | Thesis Emphasis Elective |
| CC4913 | (4-0) | C3 Policies and Problems |

EDUCATIONAL SKILL REQUIREMENTS JOINT COMMAND, CONTROL & COMMUNICATIONS CURRICULUM (365)

1. Analyze technical requirements and perform planning studies of C3 systems.

- (a) Understand and apply basic C3 systems technology.
- (b) Understand and apply basic physical principles, capabilities, and limitations of telecommunications and sensors, including radars. Include analog and digital systems with emphasis on digital systems.
- (c) Understand the atmospheric/meteorological effects on telecommunication and sensor.
- (d) Understand the capabilities and limitations of computers including networking, operating systems, software and hardware, and programming concepts.
- (e) Understand database management systems with emphasis on C3 applications.
- (f) Understand defense acquisition.
- (g) Understand the PPBS, evolutionary acquisition, PPPI program, NDI, COTS, and the CINC PPBS input with emphasis on command and control systems.

2. Understand the technical requirement for interoperability between C3 systems and the programs designed to ensure interoperability.

- (a) Understand technical interoperability parameters of command and control systems (including the path, the information traveling on the path, and the processing of the information).
- (b) Analyze and evaluate C3 systems for effectiveness and efficiency through modeling and simulations.
- (c) Design, implement, and use simulation models with emphasis on C3 and interpret the results.
- (d) Understand the relationships of intelligence, air operations, fire support and maneuver, maritime, administration and logistics, and management information systems to the C3 function.
- (e) Be familiar with programs and organizations (agencies, boards, and panels) associated with interoperability including the OSD/C3I, MCEB, IIP, JIEO Center for Standards, TPC3 Panel, and the Five Year Interoperability Assurance Plan (FYIAP); and use the architectures developed by DISA, JIEO (FIAs), DIA (TIAP, INCA), etc. as current examples.

3. Understand the role of C3 systems in military operations.

- (a) Understand the role of C3 systems in the use of military power.
- (b) Understand C3 systems.
- (c) Understand the C3 management structure of DoD.
- (d) Understand the structure of DoD and Joint and Unified Commands.
- (e) Understand the threat to C3 systems.
- (f) Understand the availability of intelligence products.
- (g) Understand the intelligence tasking process.

- (h) Understand and identify requirements for C3 systems.
- (i) Interface with engineers and operational personnel in the development of new, and the improvement of existing, C3 systems.
- (j) Interpret the impact of C3 systems on operational philosophies.
- (k) Synthesize the command and control needs of the operators/users during crisis management.

4. Understand human-C3 systems interactions and related technologies.

- (a) Understand the human's capabilities and limitations and how these can affect the optimum design of C3 systems.
- (b) Understand the impacts of different environments (air/land/sea).
- (c) Understand the relationships between information processing and collection and information overload (focus on memory).
- (d) Understand the applications of technology (e.g., DDN, voice recognition, security devices, data display— graphics, video, etc.).
- (e) Understand the relationships of accuracy, timeliness, precision, and other factors to the value of information.
- (f) Understand the application of decision support systems and artificial intelligence to the decision making process.
- (g) Understand and apply the concepts of operational analysis as it pertains to the decision making process. Include areas of probability, model formulation (linear and non- linear programming, networks, flow and scheduling, decision analysis, etc.) and statistics and data analysis.

5. Joint Maritime Strategic Planning:

American and world military history and joint and maritime planning including the origins and evolution of national and allied strategy; current American and allied military strategies which address the entire spectrum of conflict; the U.S. maritime component of national military strategy; the role of the commanders of unified and specified commands in strategic planning; the process of strategic planning; joint and service doctrine, and the roles and missions of each in meeting national strategy.

6. Practice:

The graduate will demonstrate the ability to conduct independent analysis in joint command, control and communications and proficiency in presenting the results in writing and orally by means of a thesis and command-oriented briefing.

NATIONAL SECURITY AND INTELLIGENCE PROGRAMS

Curricular Officer:

Mark Machin, CDR, USN
Code 38, Glasgow Hall, Room 220
(408) 656-2845, DSN 878-2845

Educational Technician

Dora Martinez
Code 381, Glasgow Hall, Room 215
(408) 656-2845, DSN 878-2845

Secretary

Alice Lee
Code 385, Glasgow Hall, Room 220
(408) 656-2228, DSN 878-2228

AREA STUDIES

CURRICULA 681-684

Area studies curricula focus on specific regions of strategic interest to the United States and its allies. Building on the history, culture, and religion of the region, each curriculum provides students with a knowledge of current issues, economic and political structures and institutions, military forces, including strategic capabilities and policy implications and geopolitical influences.

REQUIREMENTS FOR ENTRY

Prospective students must be military officers or civilian employees of the U.S. Federal Government or other nations. Students must have a baccalaureate degree earned with above-average academic performance and an APC of 365. TOEFL of 540 is required for international students.

ENTRY DATES

Area studies are six-quarter courses of study with entry dates in January and July. For U.S. Army and Air Force Officers there is a modified academic program which combines studies at the Defense Language Institute and the Naval Postgraduate School. If further information is needed, contact the Academic Associate or the Curricular Officer for these curricula.

Curricula 681-684

Academic Associate:

David Yost, Professor
Code NS/YO, Glasgow Hall, Room 317
(408) 656-2579, DSN 878-2579

DEGREE

Requirements for the degree of Master of Arts in National Security Affairs are met en route to satisfying the Educational Skill Requirements of the curricula.

MID EAST, AFRICA, SOUTH ASIA SUBSPECIALTY

Completion of the 681 curriculum qualifies an officer as a Mid East, Africa, South Asia Subspecialist with a subspecialty code of XX21. The curriculum sponsor is N3/5, Deputy Chief of Naval Operations (Plans, Policy and Operations).

Typical Jobs in this Subspecialty:

Operations Intelligence: Commander Middle East Force
POL-MIL Planner: Joint Chiefs of Staff, Washington, DC
Mid East/Southwest Asia Policy: CINCUSNAVEUR LONDON
Area Officer: DIA
Head, Middle East, Asia, Southwest Asia: N-521
Military Assistance Program: Military Liaison Office Tunisia

FAR EAST, SOUTHEAST ASIA, PACIFIC SUBSPECIALTY

Completion of the 682 curriculum qualifies an officer as a Far East, Southeast Asia, Pacific Subspecialist with a subspecialty code of XX22. The curriculum sponsor is N3/5 Deputy Chief of Naval Operations (Plans, Policy and Operations).

Typical Jobs in this Subspecialty:

Chief of Staff: COMNAVBASE GUAM
Staff Operations and Plans: CINCPACFLT
Faculty Member: DIC
Assistant for Military Sales: OPNAV-FOREIGN MILITARY
Analyst: OPNAVSUPPACT, Washington, DC

WESTERN HEMISPHERE SUBSPECIALTY

Completion of the 683 curriculum qualifies an officer as a Western Hemisphere Subspecialist with a subspecialty code of XX23. The curriculum sponsor is N3/5 Deputy Chief of Naval Operations (Plans, Policy and Operations).

Typical Jobs in this Subspecialty:

Political Military Planner: Joint Chiefs of Staff
Executive Assistant: Inter American Defense
Strategy and Policy Central and South Atlantic: USCINCLANT
Intelligence Analyst: USCINSCO
Area Officer: DIA
Assistant for Military Sale: OPNAV-FOREIGN MILITARY
N-523 Assistant Branch Head: South America

RUSSIA, EUROPE, CENTRAL ASIA

Completion of the 684 curriculum qualifies an officer as a Russia, Europe, Central Asia Subspecialist with a subspecialty code of XX24. The curriculum sponsor is N3/5 Deputy Chief of Naval Operations (Plans, Policy and Operations).

Typical Jobs in this Subspecialty:

Staff Plan: NATO
ACOS for Plans: SACLANT
POL-MIL Planner: Joint Chiefs of Staff
Geopolitical Intelligence Office: CINCUSNAVEUR LONDON
Atlantic Allied Plans: COMINSEWARCOM

TYPICAL COURSE OF STUDY

MIDDLE EAST, AFRICA, SOUTH ASIA - CURRICULUM 681

Quarter 1

| | | |
|--------|-------|--|
| NS3011 | (4-2) | Policy Analysis and Research Methods |
| NS3023 | (4-0) | Introduction to Comparative Politics |
| NS3300 | (4-0) | History and Cultures of the Middle East |
| NS3310 | (4-0) | Government and Politics in the Middle East |

Quarter 2

| | | |
|--------|-------|---|
| NS3040 | (4-0) | The Politics of Global Economic Relations |
| NS3030 | (4-0) | American National Security Policy |
| NS3024 | (4-0) | Introduction to International Relations |
| NS3252 | (4-0) | Joint and Maritime Strategic Planning |

Quarter 3

| | | |
|--------|-------|---|
| NS3320 | (4-0) | U.S Interests and Policies in the Middle East |
| NS3041 | (4-0) | Comparative Economic Systems |
| NS4300 | (4-0) | Seminar in Middle Eastern Politics |
| NS3037 | (4-0) | The Role of Congress in U.S. National Security Policy |

Quarter 4

| | | |
|--------|-------|---|
| NS3360 | (4-0) | Topics in Middle Eastern Politics |
| NS4310 | (4-0) | Seminar in Middle Eastern Security Issues |
| NS4XXX | (4-0) | Elective |
| NS0810 | (0-8) | Thesis Research |

Quarter 5

| | | |
|--------|-------|--------------------------------------|
| NS3361 | (4-0) | Topics in Middle Eastern Security |
| NS3902 | (4-0) | Modern Revolution |
| NS3038 | (4-0) | International Naval Power and Policy |
| NS0810 | (0-8) | Thesis Research |

Quarter 6

| | | |
|--------|-------|---------------------|
| NS4XXX | (4-0) | Elective |
| NS3XXX | (4-0) | Elective |
| NS4080 | (2-0) | Research Colloquium |
| NS0810 | (0-8) | Thesis Research |

TYPICAL COURSE OF STUDY**FAR EAST, SOUTHEAST ASIA, PACIFIC - CURRICULUM 682****Quarter 1**

| | | |
|--------|-------|---|
| NS3011 | (4-2) | Policy Analysis and Research Methods for Area Studies |
| NS3023 | (4-0) | Introduction to Comparative Politics |
| NS3600 | (4-0) | Geography and History of Asia |
| NS3601 | (4-0) | Values and Belief Systems of Asia |

Quarter 2

| | | |
|--------|-------|---|
| NS3040 | (4-0) | Politics of Global Economic Relations |
| NS3030 | (4-0) | American National Security Policy |
| NS3620 | (4-0) | Asia and the Modern World |
| NS3024 | (4-0) | Introduction to International Relations |

Quarter 3

| | | |
|--------|-------|---|
| NS3663 | (4-0) | Government and Security in Korea |
| NS3041 | (4-0) | Comparative Economic Systems |
| NS3037 | (4-0) | The Role of Congress in U.S. National Security Policy |
| NS4XXX | (4-0) | Elective |

Quarter 4

| | | |
|--------|-------|--|
| NS3667 | (4-0) | Government and Security in South Asia, Southeast Asia, and Oceanic Regions |
| NS3252 | (4-0) | Joint and Maritime Strategic Planning |
| NS4XXX | (4-0) | Elective |
| NS0810 | (0-8) | Thesis Research |

Quarter 5

| | | |
|--------|-------|--------------------------------------|
| NS3661 | (4-0) | Government and Security in China |
| NS3038 | (4-0) | International Naval Power and Policy |
| NS4660 | (4-0) | Seminar in Asia in World Affairs |
| NS0810 | (0-8) | Thesis Research |

Quarter 6

| | | |
|--------|-------|--|
| NS3662 | (4-0) | Government and Security in Japan |
| NS4690 | (4-0) | Seminar in International Security Issues of Asia |
| NS4080 | (2-0) | Research Colloquium |
| NS0810 | (0-8) | Thesis Research |

TYPICAL COURSE OF STUDY**WESTERN HEMISPHERE - CURRICULUM 683**

Quarter 1

| | | |
|--------|-------|--|
| NS3011 | (4-2) | Policy Analysis & Research Methods |
| NS3023 | (4-0) | Introduction to Comparative Politics |
| NS3501 | (4-0) | History and Culture of Latin America |
| NS3510 | (4-0) | Government and Politics in Latin America |

Quarter 2

| | | |
|--------|-------|---|
| NS3040 | (4-0) | Politics of Global Economic Relations |
| NS3030 | (4-0) | American National Security Policy |
| NS3024 | (4-0) | Introduction to International Relations |
| NS3252 | (4-0) | Joint & Maritime Strategic Planning |

Quarter 3

| | | |
|--------|-------|---|
| NS3041 | (4-0) | Comparative Economic Systems |
| NS3520 | (4-0) | Latin America International Relations |
| NS3037 | (4-0) | The Role of Congress in U.S. National Security Planning |
| NS4510 | (4-0) | Seminar on Latin American Government and Politics |

Quarter 4

| | | |
|--------|-------|---|
| NS3XXX | (4-0) | Elective |
| NS4560 | (4-0) | Seminar in Latin American Security Issues |
| NS3XXX | (4-0) | Elective |
| NS0810 | (0-8) | Thesis Research |

Quarter 5

| | | |
|--------|-------|--------------------------------------|
| NS3038 | (4-0) | International Naval Power and Policy |
| NS4XXX | (4-0) | Elective |
| NS3902 | (4-0) | Modern Revolution |
| NS0810 | (0-8) | Thesis Research |

Quarter 6

| | | |
|--------|-------|---------------------|
| NS3XXX | (4-0) | SOLIC Elective |
| NS4XXX | (4-0) | Elective |
| NS4080 | (2-0) | Research Colloquium |
| NS0810 | (0-8) | Thesis Research |

TYPICAL COURSE OF STUDY**RUSSIA, EUROPE, AND CENTRAL ASIA - CURRICULUM 684****TRACK 1 - WESTERN EUROPE****Quarter 1**

| | | |
|--------|-------|---|
| NS3011 | (4-2) | Policy Analysis and Research Methods |
| NS3023 | (4-0) | Introduction to Comparative Politics |
| NS3700 | (4-0) | History of Modern Europe |
| NS3710 | (4-0) | Government and Security in Western Europe |

Quarter 2

| | | |
|--------|-------|---|
| NS3040 | (4-0) | Politics of Global Economic Relations |
| NS3030 | (4-0) | American National Security Policy |
| NS3720 | (4-0) | European Security Institutions |
| NS3024 | (4-0) | Introduction to International Relations |

Quarter 3

| | | |
|--------|-------|---|
| NS3041 | (4-0) | Comparative Economic Systems |
| NS3460 | (4-0) | Government & Security in Eastern Europe |
| NS4710 | (4-0) | Seminar in Political and Security Problems of Europe |
| NS3037 | (4-0) | The Role of Congress in U.S. National Security Policy |

Quarter 4

| | | |
|--------|-------|---|
| NS3252 | (4-0) | Joint and Maritime Strategic Planning |
| NS3450 | (4-0) | Military Strategy in Russia, Eastern Europe, and Central Asia |

| | | |
|--------|-------|----------------------------|
| NS4720 | (4-0) | Seminar in European Issues |
| NS0810 | (0-8) | Thesis Research |

Quarter 5

| | | |
|--------|-------|--------------------------------------|
| NS3038 | (4-0) | International Naval Power and Policy |
| NS3902 | (4-0) | Modern Revolution |
| NS4XXX | (4-0) | Elective |
| NS0810 | (0-8) | Thesis Research |

Quarter 6

| | | |
|--------|-------|---------------------|
| NS3XXX | (4-0) | Elective |
| NS4XXX | (4-0) | Elective |
| NS4080 | (2-0) | Research Colloquium |
| NS0810 | (0-8) | Thesis Research |

TYPICAL COURSE OF STUDY

TRACK 2 - RUSSIA, EASTERN EUROPE, CENTRAL ASIA

Quarter 1

| | | |
|--------|-------|--|
| NS3011 | (4-2) | Policy Analysis and Research Methods |
| NS3023 | (4-0) | Introduction to Comparative Politics |
| NS3400 | (4-0) | Government and Politics in Russia, Eastern Europe and Central Asia |
| NS3410 | (4-0) | Russia, Eastern Europe, and Central Asia in World Affairs |

Quarter 2

| | | |
|--------|-------|--|
| NS3040 | (4-0) | Politics of Global Economic Relations |
| NS3030 | (4-0) | American National Security Policy |
| NS3401 | (4-0) | The Peoples of Russia, Eastern Europe and Central Asia |
| NS3024 | (4-0) | Introduction to International Relations |

Quarter 3

| | | |
|--------|-------|--|
| NS3041 | (4-0) | Comparative Economic Systems |
| NS3460 | (4-0) | Problems of Government and Security in Eastern Europe |
| NS3037 | (4-0) | The Role of Congress in U.S. National Security Policy |
| NS4410 | (4-0) | Seminar in Security Issues of Russia, Eastern Europe, and Central Asia |

Quarter 4

| | | |
|--------|-------|--|
| NS3252 | (4-0) | Joint and Maritime Strategic Planning |
| NS3450 | (4-0) | Military Strategy in Russia, Eastern Europe and Central Asia |
| NS4720 | (4-0) | Seminar in European Security Issues |
| NS0810 | (0-8) | Thesis Research |

Quarter 5

| | | |
|--------|-------|--------------------------------------|
| NS3038 | (4-0) | International Naval Power and Policy |
| NS3XXX | (4-0) | Elective |
| NS4XXX | (4-0) | Elective |
| NS0810 | (0-8) | Thesis Research |

Quarter 6

| | | |
|---------|-------|--------------------------------|
| NS33720 | (4-0) | European Security Institutions |
| NS4XXX | (4-0) | Elective |
| NS4080 | (2-0) | Research Colloquium |
| NS0810 | (0-8) | Thesis Research |

STRATEGIC PLANNING CURRICULUM 688

This curriculum provides students with a wide knowledge and thorough understanding of the complex, interrelated variables in both the domestic and international

environments when evaluating strategic planning options and supportive negotiating positions in the formulation of U.S. national security policy.

REQUIREMENTS FOR ENTRY

Open to officers and civilian employees of the U.S. Federal Government eligible for a TOP SECRET clearance with access to Sensitive Compartmented Information based on a Special Background Investigation within the past five years. A baccalaureate degree earned with above-average academic performance and a minimum APC of 335 are required.

ENTRY DATES

Strategic Planning is an eight-quarter course of study with entry dates in January and July. If further information is needed, contact the Academic Associate or the Curricular Officer for this curriculum.

Curriculum 688

Academic Associate:

James J. Wirtz, Associate Professor
Code NS/Wz, Glasgow Hall, Room 308
(408)656-3483/2521, DSN 878-3483/2521

STRATEGIC PLANNING AND INTERNATIONAL ORGANIZATIONS AND NEGOTIATIONS SUBSPECIALTY

Completion of the 688 curriculum qualifies an officer as a Strategic Planning Specialist with a subspecialty code of XX28. The curriculum sponsor is N3/5 Deputy Chief of Naval Operations (Plans, Policy and Operations).

Typical Jobs in this Subspecialty:

Representative for International Negotiations: JCS
Military Assistant: U.S. Arms Control and Disarmament
Assistant for Nuclear Negotiations: OPNAV
Head Trident Strategic Weapons: OPNAV
SSBN Current Operations: USCINCLANT
War Plans: CINCUSNAVEUR

DEGREE

Requirements for the degree Master of Arts in National Security Affairs are met en route to satisfying the Educational Skill Requirements of the curricular program.

TYPICAL COURSE OF STUDY

Quarter 1

| | | |
|--------|-------|--|
| NS3011 | (4-2) | Policy Analysis & Research Methods |
| NS3000 | (4-0) | War in the Modern World |
| NS3023 | (4-0) | Introduction to Comparative Politics |
| NS3400 | (4-0) | Government and Politics in Russia, Eastern Europe and Central Asia |

Quarter 2

| | | |
|--------|-------|---|
| NS3040 | (4-0) | The Politics of Global Economic Relations |
| NS3030 | (4-0) | American National Security Policy |
| NS3252 | (4-0) | Joint & Maritime Strategic Planning |
| NS3024 | (4-0) | Introduction to International Relations |

Quarter 3

| | | |
|--------|-------|---|
| NS3012 | (4-0) | Forecasting and Gaming Methods for Strategic Planners |
| NS3230 | (4-0) | Strategic Planning and the Military |
| NS3037 | (4-0) | The Role of Congress in U.S. National Security Policy |
| NS3XXX | (4-0) | Non-Russian Area Studies Elective |

Quarter 4

| | | |
|--------|-------|--|
| NS3250 | (4-0) | The Economics of U.S. Defense Policy |
| NS3280 | (4-0) | Nuclear Strategy and National Security |
| NS3450 | (4-0) | Military Strategy in Russia, Eastern Europe and Central Asia |
| NS3900 | (4-0) | International Law and Organizations |

Quarter 5

| | | |
|--------|-------|--|
| NS3038 | (4-0) | International Naval Power and Policy |
| Option | (4-0) | Joint Warfare Analysis Course |
| NS4280 | (4-0) | Seminar in Nuclear Strategy |
| NS3159 | (4-0) | Principles of Joint Operational Intelligence |

Quarter 6

| | | |
|--------|-------|--|
| OS3002 | (4-0) | Operations Research for Strategic Planners |
| NS4900 | (4-0) | Seminar in International Negotiations |
| Option | (4-0) | Joint Warfare Analysis Course |
| NS0810 | (0-8) | Thesis Research |

Quarter 7

| | | |
|--------|-------|---|
| NS4250 | (4-0) | Seminar in Security Assistance and Arms Transfers |
| Option | (4-0) | Joint Warfare Analysis Course |
| NS3882 | (4-0) | Difference, Compellence, and Crisis Management |
| NS0810 | (0-8) | Thesis Research |

Quarter 8

| | | |
|--------|-------|-------------------------------|
| NS4230 | (4-0) | Seminar in Strategic Planning |
| Option | (4-0) | Joint Warfare Analysis Course |
| NS4080 | (2-0) | Research Colloquium |
| NS0810 | (0-8) | Thesis Research |

SPECIAL OPERATIONS/LOW INTENSITY CONFLICT CURRICULUM 699

This curriculum is designed to provide students with specialized knowledge of the broad range of factors involved in the phenomenon of low intensity conflict, to include an appreciation of the multiple facets of the causes and consequences of different forms of political violence, ranging from terrorism to mid-level conflict.

REQUIREMENTS FOR ENTRY

Curriculum is open to officers and civilian employees of the U.S. Federal Government or other nations. U.S. officers must be eligible for a TOP SECRET clearance with access to Sensitive Compartmented Information based on a Special Background Investigation completed within the past five years. A baccalaureate degree earned with above-average academic performance and minimum APC of 365.

ENTRY DATES

Special Operations/Low Intensity Conflict is a six-quarter course of study with an entry date in July. If further information is needed, contact the Academic Associate or the Curricular Officer for this curriculum.

CURRICULUM 699

Academic Associate:

Gordon H. McCormick, Associate Professor
Code NS/Mc, Glasgow Hall, Room 379
(408) 656-2521, DSN 878-2521

Program and Research Coordinator:

Jennifer Duncan
Code NS/JD
(408) 656-3582, DSN 878-2521

SPECIAL OPERATIONS/LOW INTENSITY CONFLICT SUBSPECIALTY

Completion of the 699 curriculum qualifies an officer as a Special Operations/Low Intensity Conflict Subspecialist with a subspecialty code of XX29. The curriculum

sponsor is Commander in Chief, Special Operations Command.

Typical Jobs in this Subspecialty:

Chief, Political Strategy: USCINCSOC

Asst Missions/Readiness: ASD (SO/LIC)

Special Warfare Plans: CINCLANT/CINCPAC/NACEUR

Chief Intel/Plans: COMNAVSPECWARCOM

Joint Plans/Doctrine: COMNAVSPECWARCOM

Staff Plans: CNSWG-1

TYPICAL COURSE OF STUDY

Quarter 1

| | | |
|---------|-------|--|
| NS3011 | (4-2) | Policy Analysis & Research Methods |
| NS3023 | (4-0) | Introduction to Comparative Politics |
| NS3000 | (4-0) | War in the Modern World OR |
| (NS3252 | (4-0) | Joint and Maritime Strategic Planning) |
| NS3902 | (4-0) | Modern Revolution |

Quarter 2

| | | |
|---------|-------|--|
| NS3000 | (4-0) | War in the Modern World OR |
| (NS3252 | (4-0) | Joint and Maritime Strategic Planning) |
| NS3024 | (4-0) | Introduction to International Relations |
| NS4031 | (4-0) | Ethno-Nationalism |
| NS4850 | (4-0) | Regional Seminar in Low Intensity Conflict: Latin America |

Quarter 3

| | | |
|--------|-------|---|
| NS3037 | (4-0) | The Role of Congress in U.S. National Security Policy |
| NS3880 | (4-0) | History of Special Operations |
| NS4830 | (4-0) | Regional Seminar in Low Intensity Conflict: Middle East |
| NS3882 | (4-0) | Deterrence, Compellence, and Crisis Management |

Quarter 4

| | | |
|--------|-------|--|
| NS4860 | (4-0) | Regional Seminar in Low Intensity Conflict: Asia |
| NS3801 | (4-0) | International Terrorism |
| NS3030 | (4-0) | American National Security Policy |
| NS3XXX | (4-0) | Area Studies Elective |

Quarter 5

| | | |
|--------|-------|---|
| NS3036 | (4-0) | The Military and Politics in the Developing World |
| NS0810 | (0-8) | Thesis Research |
| NS3800 | (4-0) | Theory and Practice of Social Revolution |
| NS4880 | (4-0) | Seminar in Legal & Military Responses to Political Violence |

Quarter 6

| | | |
|--------|-------|--|
| MN3XXX | (4-0) | Military and Legal Responses to Political Violence |
| NS4080 | (2-0) | Research Colloquium |
| NS0810 | (0-8) | Thesis Research |
| NS0810 | (0-8) | Thesis Research |

RESOURCE PLANNING AND MANAGEMENT FOR INTERNATIONAL DEFENSE CURRICULUM 820

The Resource Planning and Management for International Defense Curriculum is an interdisciplinary program, designed exclusively for officers and civilian employees in defense agencies of other countries. The program focuses on economic analysis, the management of financial, material, and human resources, domestic and international political institutions, civil-military relations, and the role of international law. The curriculum is made up of a combination of existing courses within the Systems Management and National Security Affairs departments and courses especially designed for this program. In the majority of courses, international students will study and learn with U.S. students from several other

management and national security affairs curricula.

REQUIREMENT FOR ENTRY

A baccalaureate degree with above-average grades, fluency in written and verbal english, and a minimum score of 540 on the *Test of English as a Foreign Language* (TOEFL). Supplemental English language training is required for students who score 500-539.

Officers and civilian employees in defense agenices of other countries enter the curriculum with widely varied academic and military backgrounds and are evaluated on an indivdual basis. Validation or credit by examination is encouraged.

ENTRY DATES

Resource Planning and Management for International Defense Curriculum 820 is a six-quarter (18 months) course of study with an entry date of January. If further information is needed, contact the Academic Associate for the curriculum or the Curricular Officer.

Curriculum 820

Academic Associate:

Roger Evered, Professor

Code AS/Ev, Ingersoll Hall, Room 201

(408) 656-2646, DSN 878-2646

DEGREE

Master of Science in International Resource Planning and Mangement

Quarter 1

| | | |
|--------|-------|---|
| MN2150 | (4-0) | Financial Accounting |
| NS3023 | (4-0) | Intro to Comparative Politics |
| MN2039 | (4-0) | Basic Quantitative Methods in Econ Analysis |
| IT1500 | (3-0) | American Life and Institution |
| IS0123 | (0-2) | Computer Skills Development |

Quarter 2

| | | |
|--------|-------|-----------------------------------|
| MN3161 | (4-0) | Management Accounting |
| NS3030 | (4-0) | American National Security Policy |
| NS3140 | (4-0) | Microeconomic Theory |
| MN3172 | (4-0) | Public Policy and Budgeting |

Quarter 3

| | | |
|--------|-------|---|
| MN3333 | (4-0) | Managerial Communication |
| NS3036 | (4-0) | Military & Politics in the Developing World |
| NS3041 | (4-0) | Comparative Economic Systems |
| MN3105 | (4-0) | Organization and Management |

Quarter 4

| | | |
|--------|-------|-------------------------------------|
| IS3183 | (4-0) | Management Information Systems |
| NS3900 | (4-0) | International Law and Organizations |
| MN4145 | (4-0) | Policy Analysis |
| MN3111 | (4-0) | Personnel Management Processes |

Quarter 5

| | | |
|--------|-------|---|
| MN0810 | (0-8) | Thesis |
| NS3037 | (4-0) | Role of Congress in U.S. National Security Policy |
| MN0810 | (0-8) | Thesis |
| | | Elective |

Quarter 6

| | | |
|--------|-------|--------|
| MN0810 | (0-8) | Thesis |
|--------|-------|--------|

| | | |
|--------|-------|--|
| NS4240 | (4-0) | Seminar on Regional Security Planning Problems |
| MN0810 | (0-8) | Thesis |
| MN4105 | (4-0) | Strategic Management |

INTELLIGENCE CURRICULUM 825

The Joint Intelligence curriculum is composed of three distinct tracks, each of which is tailored to meet the billet requirements of major resource claimants, such as Unified Commanders-In-Chiefs, and to satisfy the educational skill requirements for one of three existing subspecialties: (1) Scientific and Technical Intelligence (XX17P); (2) Regional Intelligence (XX18P); and, (3) Operational Intelligence (XX19P). These are rigorous curricula which are founded in traditional academic disciplines that combine to create the field of intelligence studies. All three curricula provide an interdisciplinary graduate education. All three curricula require a thesis. The Regional Intelligence curriculum requires satisfactory completion of language training at DLI prior to award of the Masters of Arts degree and the subspecialty designator. In contrast to the previous curricula offered just a few years ago, which were aimed exclusively at naval intelligence officers and a few general unrestricted line officers, the present NPS intelligence curricula encompass educational objectives suitable to all services as well as to some Federal agencies.

REQUIREMENTS FOR ENTRY

Prospective students must be U.S. military officers or civilian employees of the U.S. Federal Government eligible for a TOP SECRET clearance with access to Sensitive Compartmented Information based on a Special Background Investigation completed within the past five years. They must have a baccalaureate degree earned with above-average academic performance and a minimum APC of 223 (Track 1), 365 (Track 2), or 235 (Track 3).

ENTRY DATES

Scientific and Technical Intelligence (Track 1) is a six quarter program with a starting date in April. In addition, all students will report for a math and physics refresher in mid-February. Regional Studies Intelligence (Track 2) is a five quarter program with a starting date in July. Language training follows completion of NPS education. Operational Intelligence (Track 3) is a six quarter course of study with a start date in July. If further information is needed, contact the Academic Associate or the Curricular Officer for this curriculum.

INTELLIGENCE SUBSPECIALTY

Completion of any of the three curricula qualifies an officer as an Intelligence Subspecialist with one of the following intelligence subspecialty codes:

| | |
|------------------------------------|------|
| Track 1 - Scientific and Technical | XX17 |
| Track 2 - Regional | XX18 |
| Track 3 - Operational | XX19 |

Typical Jobs in this Subspecialty:

Operations Intelligence Analyst: ONI, Washington, DC

Technical Intelligence: COMNAVFOR JAPAN

Naval Attache: Attache USSR

Intelligence Officer: COMSUBGRU

DEGREE

Requirements for the degree Master of Science in National Security Affairs are met en route to satisfying the Educational Skill Requirements of the Scientific and Technical Intelligence (Track 1) program. Requirements for the degree Master of Arts in National Security Affairs are met en route to satisfying the Educational Skill Requirements of the Regional Studies Intelligence or Operational Intelligence programs.

Curriculum 825

Academic Associate:

Peter R. Hull, Military Instructor

Code NS/HI, Glasgow Hall, Room 380

(408)656-3401/2521, DSN 878-3401/2521

TYPICAL COURSE OF STUDY

TRACK 1 - SCIENTIFIC AND TECHNICAL INTELLIGENCE

Quarter 1 (REF)

| | | |
|---------|-------|------------------------------------|
| MAR118 | (3-3) | Refresher: Multi-Variable Calculus |
| PH1001 | (4-2) | Mechanics OR |
| (PH1002 | (4-2) | Electricity & Magnetism) |
| MAR142 | (2-0) | Refresher: Matrix Algebra |
| EC1010 | (1-0) | Introduction to MATLAB |

Quarter 2

| | | |
|--------|-------|--|
| EC2100 | (3-2) | Circuit Analysis I |
| EO2413 | (4-2) | Comm. Systems I: Intro to Signals and Analog Systems |
| MA2121 | (4-0) | Differential Equations |
| MA3560 | (3-0) | Modern Applied Algebra |

Quarter 3

| | | |
|--------|-------|-------------------------------------|
| EO3513 | (4-2) | Comm. Systems Engineering |
| CS3200 | (3-2) | Computer Architecture |
| SS3001 | (3-2) | Military Applications of Space |
| NS3230 | (4-0) | Strategic Planning and the Military |

Quarter 4

| | | |
|--------|-------|---------------------------------------|
| CS3010 | (4-0) | Computer Systems Principles |
| EO3523 | (4-2) | Comm. Systems Analysis |
| IS3502 | (4-0) | Computer Networks: Wide/Local Area |
| NS3252 | (4-0) | Joint and Maritime Strategic Planning |

Quarter 5

| | | |
|--------|-------|----------------------------------|
| SE4006 | (4-0) | Technical Weapons Assessment |
| EC3670 | (4-2) | Principles of Radar Systems |
| IS4502 | (4-0) | Telecommunications Networks |
| NS4141 | (4-0) | Seminar in Economic Intelligence |

Quarter 6

| | | |
|--------|-------|--------------------|
| CS4601 | (4-0) | Computer Security |
| EC3910 | (V-0) | SIGINT Systems |
| EC4670 | (4-1) | Electronic Warfare |
| NS0810 | (0-8) | Thesis Research |

Quarter 7

| | | |
|--------|-------|--|
| NS0810 | (0-8) | Thesis Research |
| NS3000 | (4-0) | War in the Modern World |
| NS3159 | (4-0) | Principles of Joint Operational Intelligence |
| NS4080 | (2-0) | Research Colloquium |

TRACK 2 - REGIONAL INTELLIGENCE

Quarter 1

| | | |
|--------|-------|------------------------------------|
| NS3011 | (4-2) | Policy Analysis & Research Methods |
| NS3XXX | (4-0) | Regional Emphasis |
| NS3XXX | (4-0) | Regional Emphasis |
| NS3023 | (4-0) | Comparative Politics |

Quarter 2

| | | |
|--------|-------|-------------------|
| NS3XXX | (4-0) | Regional Emphasis |
|--------|-------|-------------------|

| | | |
|--------|-------|---|
| NS3000 | (4-0) | War in the Modern World |
| NS3024 | (4-0) | Introduction to International Relations |
| NS3160 | (4-0) | Human Intelligence |

Quarter 3

| | | |
|--------|-------|-------------------------------------|
| NS0810 | (0-8) | Thesis Research |
| NS3240 | (4-0) | Military Innovation & Joint Warfare |
| NS4160 | (4-0) | Foreign Intelligence Services |
| NS4XXX | (4-0) | Regional Emphasis |

Quarter 4

| | | |
|--------|-------|--------------------------------------|
| NS0810 | (0-8) | Thesis Research |
| NS3252 | (4-0) | Joint & Maritime Strategic Planning |
| NS41XX | (4-0) | Regional Capstone |
| NS4152 | (4-0) | Joint Warfare: Intelligence Analysis |

Quarter 5

| | | |
|--------|-------|-------------------------------|
| NS0810 | (0-8) | Thesis Research |
| NS4XXX | (4-0) | Regional Capstone |
| NS4XXX | (4-0) | Seminar in American Diplomacy |
| NS4080 | (2-0) | Research Colloquium |

Note: This first year of study at the Naval Postgraduate School is followed by appropriate language studies at the Defense Language Institute.

TRACK 3 - OPINTEL

Quarter 1

| | | |
|--------|-------|---|
| NS3000 | (4-0) | War in the Modern World |
| NS3011 | (4-2) | Policy Analysis and Research Methods |
| NS3023 | (4-0) | Introduction to Comparative Politics |
| NS3041 | (4-0) | Comparative Economic Systems (1630) OR |
| NS3159 | (4-0) | Principles of Joint Operational Intelligence (non-1630) |

Quarter 2

| | | |
|--------|-------|---|
| NS3024 | (4-0) | Introduction to International Relations |
| NS3030 | (4-0) | American National Security Policy |
| NS3040 | (4-0) | The Politics of Global Economic Relations |
| NS3160 | (4-0) | Human Intelligence |

Quarter 3

| | | |
|--------|-------|---|
| NS3037 | (4-0) | The Role of Congress in U.S. National Security Policy |
| NS3240 | (4-0) | Military Innovation & Joint Warfare |
| NS4141 | (4-0) | Seminar in Economic Intelligence |
| NS4160 | (4-0) | Foreign Intelligence Services |

Quarter 4

| | | |
|--------|-------|--|
| NS3171 | (4-0) | Joint Intelligence Data Systems and Connectivity |
| NS3801 | (4-0) | International Terrorism |
| NS3250 | (4-0) | The Economics of U.S. Defense Policy |
| NS4152 | (4-0) | Seminar in Intelligence and Threat Analysis |

Quarter 5

| | | |
|--------|-------|---|
| NS0810 | (0-8) | Thesis Research |
| NS4250 | (4-0) | Seminar in Security Assistance and Arms Transfers |
| NSXXXX | (4-0) | Regional Emphasis |
| EW4000 | (4-0) | Space Applications of EW |

Quarter 6

| | | |
|--------|-------|---------------------------------------|
| NS0810 | (0-8) | Thesis Research |
| NS4080 | (2-0) | Research Colloquium |
| NS3252 | (4-0) | Joint and Maritime Strategic Planning |
| NSXXXX | (4-0) | Regional Emphasis |

EDUCATIONAL SKILL REQUIREMENTS
AREA STUDIES
CURRICULA (681, 682, 683, and 684)

1. UNDERSTAND REGIONAL SECURITY MATTERS

- a. Politics: Major political systems, political culture and governmental organizations, current political ideologies, and their impact on regional security; sources of political instability; current relationships, attitudes and perspectives toward the United States; relationships between various states in the region, emphasizing the security aspect and potential for military conflict.
- b. Strategic Posture: National and regional strengths and weaknesses that affect the nations' strategic posture and capabilities; major military, political, economic and sociological trends which affect policy security choices.
- c. Military Forces: The composition, structure, capabilities, vulnerabilities, roles and missions, and political influence of the armed forces in the region; current politico-military developments, regional politico-military relations, and regional defense arrangements; analysis, as appropriate, of classified intelligence information on regional military developments.
- d. U.S. Military Strategy: U.S. Military Strategy for the selected region.
- e. Ethnicity, Culture and Religion: The influence of ethnic, cultural and religious values on security situation; ethnic conflicts, political instability and violence.
- f. Economics: The economic strengths and weaknesses of the region, and the economic factors which influence political ideology, military doctrine and capabilities, and industrial and social development. This topic includes familiarity with the economics of the region and its principal resources, industrial capacity, defense industry, manpower availability, trade issues and patterns.

2. UNDERSTAND GENERAL SECURITY MATTERS

- a. U.S. Security Policy: The formulation and execution of U.S. national security policy, including an analysis of international relations, and of the instruments available to the U.S. Government to obtain its political and strategic objectives.
- b. Military History and Defense Organization: The history of the American military including the origins and evolution of current U.S. strategy; the internal structure of the U.S. defense establishment, and its relationship with the other components of the U.S. Government.
- c. Military Strategy: Overview of American and world military history and joint and maritime planning including the origins and evolution of national

and allied strategy; current American and allied military strategies which address the entire spectrum of conflict; the U.S. maritime component of national military strategy; the organizational structure of the U.S. defense establishment; the role of the commanders of unified and specified commands in strategic planning; the process of strategic planning; joint and service doctrine, and the roles and missions of each in meeting national strategy.

- d. Current Security Challenges: The major security issues in the world including political and military conflicts, insurgencies and terrorism, social and economic problems, and other issues that affect the status of particular nations in the context of their relationship to U.S. national security policy.

3. PRACTICE SKILLS

The graduate will demonstrate the ability to conduct independent analysis in National Security Affairs Area Studies and proficiency in presenting the results in writing and orally by means of research papers and presentations.

EDUCATIONAL SKILL REQUIREMENTS STRATEGIC PLANNING AND INTERNATIONAL ORGANIZATIONS & NEGOTIATIONS (688)

1. UNDERSTAND THREATS:

Russian: The historical development and decline of the U.S.S.R. and the Warsaw Pact; the relationship of Russian political economic and military doctrine; Russian political and military involvement in the third world; nuclear and conventional military doctrine and strategy, Russian role in nuclear proliferation; Russian resources and mobilization potential; and a net assessment of U.S./Russian economic and military strength.

Other threats: Other threats to U.S. interests and those of its allies, including such issues as Middle East confrontations, the Arab/Israeli conflict; the growth of international terrorism; threats in the Pacific Rim including North Korea, China, and Vietnam; instability in Latin America and Africa; the proliferation of nuclear, chemical, and biological weapons; missile technology proliferation; and other issues of contemporary concern.

2. UNDERSTAND FORMULATION OF U.S. POLICY:

The formulation of U.S. National Security Policy and Foreign Policy, including the role of the President, NSC, intelligence organizations, Congress, Department of State, Department of Defense, JCS, and interagency groups in policy formation and the range of measures available to the U.S. to meet its policy objectives, such as arms control agreements, security assistance, membership in international organizations, bilateral diplomacy, and application of military power.

3. UNDERSTAND DEVELOPMENT AND EXECUTION OF MILITARY STRATEGY:

American and world military history and joint and maritime planning including the origins and evolution of national and allied strategy; current American and allied military strategies which address the entire spectrum of conflict; the U.S. maritime component of national military strategy; the organizational structure of the U.S. defense establishment; the role of the commanders of unified and specified commands in strategic planning; the process of strategic planning; joint and service doctrine, and the roles and missions of each in meeting national strategy.

4. KNOW THE MILITARY ASSETS AVAILABLE TO MEET NATIONAL OBJECTIVES:

- a. Nuclear Forces - U.S. nuclear capabilities and doctrine including capabilities of each Service; current and projected Soviet nuclear capabilities and doctrine; current and projected capabilities of China, France, the United Kingdom and Third World countries; and basic nuclear weapon allocation and application theory including weapon foot printing, nuclear planning factors, and the targeting process (510P and TNF) at JSTPS, Dahlgren, etc.

- b. Space Forces - Development of SDI including doctrine for use, potential capabilities, and economic, political, and technological restraints; ASAT and other military applications of space; launch capabilities; and supportability issues of the U.S. space program.
- c. Chemical and Biological Weapons - Doctrine regarding the use of chemical and biological weapons, global balance of these weapons, treaties regarding their production and employment, and history of their use.
- d. Logistics - Mobilization capability of the U.S. and its allies including the adequacy of their industrial bases, natural resource supplies, reserve forces, sealift and airlift, etc. to meet strategic planning objectives; the role of mobilization in deterrence; and the importance of logistics throughout the planning process.
- e. Conventional Forces - U.S. conventional capabilities with emphasis in naval forces and recent developments in naval warfare.

5. UNDERSTAND NONMILITARY INSTRUMENTS OF NATIONAL STRATEGIES:

- a. Technology - The role of technology in the development of defense strategy and the implication for national security.
- b. Economics - Implications of U.S. defense budgets on the American economy, political factors involved in the formulation of the defense budget, and the mechanics of the defense budgeting process (PPBS).
- c. Intelligence - U.S. intelligence resources, methodologies, and reliability.
- d. Diplomacy - Use of negotiations, trade agreements, and other diplomatic measures to achieve national objectives.

6. UNDERSTAND THE DEVELOPMENT AND SUBSTANCE OF THE INTERNATIONAL POLITICAL SYSTEM:

The current international structure has evolved because of cultural, economic, and strategic factors, technological advances, resource shortfalls, economic interdependencies, and military balance.

7. UNDERSTAND COMPONENTS OF INTERNATIONAL NEGOTIATIONS:

- a. International Law - The rudiments of international law including law of the sea and the laws of war.
- b. Arms Control - The foundation and mechanics of bilateral and multilateral arms control efforts, and the implications on American strategy and the global political structure.
- c. Alliances - U.S. involvement in alliance relationships, including a thorough understanding of the history and substance of NATO and U.S. alliances with Japan and Korea, and other alliances such as the Organization of American States and agreements with Japan, Thailand, etc.

- d. Military Power - An overview of the world's military balance and the history of the use of military power in achieving national political objectives.
- e. Security Assistance - The use of security assistance to achieve political and strategic objectives, and the problems associated with it.

8. UNDERSTAND THE INFLUENCES OF CULTURE, RELIGION AND IDEOLOGY:

The influence of class structure and of national, ethnic, cultural, and religious values on domestic and foreign affairs, and the influence these factors have on international negotiations and the formulation of U.S. foreign policy.

9. UNDERSTAND CURRENT INTERNATIONAL ISSUES:

The major current issues in the world including social and economic problems, human rights, transnational issues (drugs, environment, population, etc.), and other issues that affect the status of nations and may have an impact on or threaten the interests of the U.S. and its allies. These issues should be addressed in the context of their relationship to U.S. foreign and security policies.

10. PRACTICE SKILLS:

The graduate will demonstrate the ability to conduct independent analysis in strategic planning and international organizations and negotiations and proficiency in presenting the results in writing and orally by means of a thesis and command-oriented briefing.

SPECIAL OPERATIONS AND LOW INTENSITY CONFLICT CURRICULUM (699)

SUMMARY REQUIREMENTS

The Special Operations and Low intensity Conflict Curriculum is designed to provide a focused course of study of the conflict spectrum below general conventional war. Graduates of this curriculum will possess a close knowledge of the broad range of factors involved in the planning and conduct of these forms of conflict and a detailed understanding of the role of special operations and related forces in U.S. foreign and defense policy. The curriculum examines the sources and dynamics of inter-state and intra-state conflict, the challenge these forms of conflict have posed and are likely to increasingly pose for U.S. security planning, political and military decisionmaking mechanisms pertaining to "low-intensity conflict," the doctrinal and institutional evolution of the U.S. special operations community, the recent history of political violence and "small wars" in Latin America, Asia, and the Middle East, the history of irregular warfare, and contemporary perspectives on low intensity conflict resolution. These curriculum specific requirements are supported by a larger, department-wide program of study which provides the graduate with a broad background in the areas of international relations, comparative politics, U.S. foreign and defense policy, general military history, joint and maritime strategic planning and analytical methods.

SPECIFIC REQUIREMENTS

There is no counterpart to the SO/LIC curriculum in any government or civilian institution. The curriculum was designed specifically to reflect the rapidly changing orientation of U.S. security policy in a post-cold war world. This changing orientation has been clearly noted in recent defense guidance which has taken on an increasingly "contingent" cast over the past four years. It has also been reflected graphically in the changing nature of the international conflict environment itself, which is being increasingly characterized by the proliferation of locally driven ethnic, communal and political wars. These conflicts, in most cases, are not occurring despite the end of the Cold War, but because of it. The collapse of the Soviet Union and the corresponding recession of the U.S. global presence have catalyzed a train of events that can be expected to lead to more rather than fewer local engagements in the foreseeable future. While these conflicts may be local in origin, they cannot always be expected to remain local in scope or threaten the interests of only local participants. The SO/LIC curriculum was established to examine the nature of the challenge this new environment will pose to United States interests and security planning over the coming decade. The specialized focus of the curriculum is expressed in its Educational Skill Requirements.

1. The Dynamics of Inter-State and Intra-State Conflict:

An understanding of the political, ethnic, and cultural dynamics that explain the outbreak of war between and within modern states. Particular attention should be given to the issues of intra-state conflict, unconventional forms of inter-state military rivalry, the integrated role of force and diplomacy in crisis management operations short of war, problems of escalation in a crisis environment, military alliance behavior, the dynamic differences between zero sum and nonzero sum conflicts, the special problems associated with suppressing and resolving zero sum engagements, and military and nonmilitary approaches to conflict resolution. Students must have a close understanding of the prevailing analytical literature on these and related subjects and be able to apply this literature to a broad range of contemporary and historical cases.

2. Terrorism, Social Revolution, and Unconventional Warfare:

A detailed understanding of the problems of domestic and international terrorism, social revolution, and other forms of irregular conflict. Close attention must be given to problems of both threat and response. The student must have a close knowledge of the prominent contending theoretical perspectives on the problems of terrorism and social revolution, a detailed knowledge of the operational and organizational dynamics underlying each of these forms of conflict, and a strong working understanding of the ways in which these and similar forms of irregular conflict have been countered historically.

3. The Evolution of SO/LIC Institutions, Doctrine, and Concepts

A detailed understanding of the development of U.S. forces, associated institutions, and doctrine for special operations and low intensity conflict. Work in this area should focus, first, on the defining events and experiences that have stimulated doctrinal and institutional innovations in SO/LIC and related areas and, second, on the forms these innovations have taken. This examination should cover the period from the end of World War II through the end of the Cold War. Having traced this evolution, attention should be given to developing a frame of reference for understanding the nature of "limited operations" in the post-Cold War era. These and related issues should be explored creatively in an effort to uncover the appropriate roles and missions and strengths and limitations of military power in the emerging multipolar environment. With this background, this effort goes on to explore the challenges that are likely to confront the U.S. planners in this area in the future.

4. Historical and Comparative Perspectives on Special Operations

A close understanding of the historical use of special operations forces, to include how these and similar forces have been organized, trained, equipped, directed, and employed. Attention should be given not only to the U.S. experience but to other national experiences as well, such as those of Great Britain, Germany, Italy, and the former Soviet Union. Similarly, this examination should not be restricted to contemporary history alone, but should extend back into the historical record to examine the ways in which special operations and related forces have been employed creatively to support state objectives in the more distant past. Throughout this inquiry attention should be given to the contemporary lessons that can be drawn from historic experience.

5. Crisis Management and the Contingent Use of Military Power

An understanding of the political role played by military power in operations short of war, the problem of military crisis management, and the contingent use of force in support of local U.S. policy objectives. Attention should be given to the "signaling" role that can be played by military force, the special problems of deterrence and coercion in a crisis environment, and the military consequences of deterrence failure. The student should have a close knowledge of the historical record of "armed diplomacy" throughout the post-war period. This should include a knowledge of the individual cases of U.S. military intervention in the Third World, from Lebanon (1958) to Somalia (1993). Attention should be given to both the theoretical and empirical literature on these subjects to provide the student with an understanding of the special political and operational issues associated with operation in a crisis environment.

6. Comparative Cases of and Responses to Low Intensity Conflict

A close knowledge of historical and contemporary "small wars" and other forms of low intensity conflict in Latin America, Asia, and the Middle East. The courses that satisfy this requirement should examine the pertinent theoretical literature on political violence in the region in question, review the recent history of regionally-based terrorism, insurgency, and communal conflict, the regional and international implications of these conflicts, and any functional issues that are of particular

interest or concern in the particular area under investigation. The latter, for example, might include the religious sources of political violence in the Middle East or the interrelationship between narcotics and insurgency in the Far East and Latin America. The larger purpose of this effort will be to provide the student with an advanced, regionally-based understanding of the contemporary conflict environment.

7. Civil-Military Relations and Politics in the Third World

A knowledge of the diverse and often central political roles played by military and paramilitary establishments in the Third World. Particular attention should be given to the character and dynamics of Third World civil-military relations, patterns of military involvement in political life, the varied pressures and motivations that underlie military coups in the Third World, and the consequences of coups for political order. Attention should be given to differentiating between different classes of military coups, the relationship between national political culture and military intervention, the varying methods of intervention open to the armed forces, the different forms of military government, and the problems inherent in the transition back to civilian rule. Case examples should be drawn from Latin America, the Middle East, Asia, and Africa with the intention of identifying broad common and regional patterns in the rise and fall of Third World civil-military relations.

8. Joint Maritime and Strategic Planning After the Cold War

A close knowledge of the system and procedures for national and service strategic formulation and operational planning after the Cold War. Attention should be given to the organizational and procedural bases of the strategic and operational planning establishment, the varied roles played in the formulation, execution, and review of military plans by the Office of the Secretary of Defense, the Joint Staff, and the unified roles, missions, and doctrines of the individual services and the direction these have taken since the end of the Cold War. While special attention should be devoted to examining post Cold War developments, this should take place within the context of the larger evolution of service and joint service military doctrine since World War II. The strengths and limitations of joint service planning should be discussed in the context of evolving U.S. defense policy.

9. The Organization and Formulation of U.S. Security Policy

A knowledge of the institutions, processes, and procedures involved in the formulation of U.S. foreign and defense policy, including the roles and interrelationships between the White House, National Security Council, Congress, Department of State, Department of Defense, the Joint Chiefs of Staff, and the intelligence community. Attention should also be given to the range of instruments available to meet U.S. foreign and defense policy objectives, including the application of force, bilateral and multilateral diplomacy, alliance and coalition formulation, the use of international organizations, security and economic assistance, and the use of covert operations. The student should have a close working knowledge of how these and similar instruments of policy are combined and recombined to advance and secure U.S. interests internationally.

10. International Relations and Comparative Political Theory

A close knowledge of the dominant analytical approaches to the study and practice of international relations and comparative politics. The student should be familiar with the recent historical and contemporary literature on these subjects, understand the alternative theoretical paradigms that are available to the analyst and decision maker, and have the ability to apply these "ideal" frames of reference to "real world" problems. Special attention should be given to the role of force in the international system the interrelationship between domestic political structures and international relations, the nonmilitary instruments of international diplomacy, the role of international organizations within the international system, the prospects for and limitations of multilateral cooperation on problems of interstate and intrastate security, the domestic and international roots of international instability, and the ways in which the dynamics of the international system have changed with the disintegration of the Soviet Union the end of the Cold War.

THE THESIS REQUIREMENT

Each student in the curriculum is required to produce a thesis on a topic that is pertinent to the broad educational goals of the program. The process of defining, researching, and writing this thesis is an important mechanism through which the larger "skill requirements" of the curriculum are achieved. Each thesis is evaluated on the basis of its originality, its analytical rigor, and its relevance to the operational, policy and/or research communities concerned with SO/LIC related issues. The thesis is the capstone of the student's program. The process begins during the first quarter, where he or she is introduced to the demands of original thesis research and encouraged to consider a broad range of alternative issue areas and topics. In contrast to the larger academic community, where original field research will typically be carried out only by advanced doctoral students, the curriculum encourages and supports student research travel where this is necessary to develop a high level of expertise in an area that is important to program and sponsor goals. The thesis provides students with an avenue to support and extend the research and planning requirements of a range of sponsoring offices. Each year suggested research topics are solicited from SOCOM, the Joint Staff, and the Office of the Assistant Secretary of Defense for Special Operations and Low Intensity Conflict. Finally, the thesis process will permit the student to develop a special expertise in areas that are important to their long run professional interests and focus.

SUPPORTING CURRICULUM ACTIVITIES

The SO/LIC curriculum is supported by 1) an extensive guest lecture series, 2) a short course series, in which prominent speakers from the larger academic community visit the curriculum for a week to ten days to give a series of seminars and lectures, and 3) an annual symposium and associated series of workshops on subjects related to the program's scope. The curriculum currently hosts between 20 and 25 guest speakers a year, drawn from the academic, policy, intelligence, and operational communities. These are supplemented by a short course each quarter to complement the established course curriculum. The short course program allows the curriculum to further differentiate its faculty base, provide a more extensive range of course topics that could otherwise be offered in an 18 month curriculum, and provide course coverage of issues of immediate topical interest. Such activities can only be conducted on the scale that they are at an institution like the Naval Postgraduate School, which serves as a natural bridge between the operational, policy making, and larger academic communities. Collectively, they introduce the student to a greater range of prominent individuals, issues, and schools of thought on SO/LIC related issues than they would encounter anywhere else. They are an essential component of the SO/LIC curriculum.

CLASSIFIED EDUCATION AND STUDENT RESEARCH

Many of the classes, guest lectures, and theses carried out within the SO/LIC curriculum are classified, in whole or in part. The ability to handle pertinent subjects in a classified setting must be an essential aspect of any program in the area of Special Operations and Low Intensity Conflict. The opportunity to conduct classified research will prove to be particularly useful in matching student thesis research with the particular research needs of the special operations community and other associated sponsors. These requirements, many of which can only be addressed at a classified level, can be satisfied at the same time that the student is satisfying the requirements for his or her degree.

EDUCATIONAL SKILL REQUIREMENTS RESOURCE PLANNING AND MANAGEMENT FOR INTERNATIONAL DEFENSE (REPMID) CURRICULUM (820)

1. SCHOLARLY METHODS

Understand the issues of politics and management of defense resources in their human, material, and financial dimensions. Analyze questions of immediate policy in a variety of allied fields. Present findings of advanced research.

2. U.S. DEFENSE ORGANIZATION

Understand the evolution and character of U.S. and foreign defense institutions in the past, present and future: interpret the role of various agencies, personalities, and issues. Compare developments in the United States with those in the student's native country and determine how such comparisons between national experience may or may not apply to questions of contemporary policy.

3. COMPARATIVE CIVIL/MILITARY RELATIONS

Interpret the theoretical and practical aspects of how civilians and the military interact in a variety of national experiences. Particular attention is paid to the role of militaries in various kinds of political and social systems, with due regard for the theory and practice of civil/military relations in the Atlantic experience, in South America, Africa, and Asia. Apply an understanding of civil/military relations to questions of defense resources in modern governments in several national experiences.

4. MILITARY AND CIVILIAN INTERACTION IN WORLD MILITARY INSTITUTIONS AFTER 1989

Interpret the character of civil/military interaction in changing defense organizations of the post-1989 world. Acquire knowledge of military customs and practices in political and social realms in the first half of the 20th century. Particular emphasis is placed on the impact of the end of the cold war upon leading world militaries and their use of human, financial, and material resources within the larger political struggle for international competitiveness and an unsettled international system of states.

5. DEMOCRACY, LAW, AND RESOURCES IN DEFENSE INSTITUTIONS

Understand the role of parliamentary government and due process of law in the U.S. military, as well as that of other national experiences across a broad international spectrum. Analyze the role of civilian institutions in controlling military matters such as defense budgeting, military operations, covert operations, and the role of various ethnic and minority groups in society as they pertain to military institutions.

EDUCATIONAL SKILL REQUIREMENTS JOINT INTELLIGENCE CURRICULUM (825)

SCIENTIFIC AND TECHNICAL INTELLIGENCE (TRACK 1)

1. **MATHEMATICS AND SCIENCE:** A graduate level foundation in mathematics and science to include single- and multi-variable calculus, matrix algebra, differential equations, applied probability, mechanics, electricity and magnetism.
2. **COMPUTERS AND COMPUTER SYSTEMS:** The officer will understand the capabilities, limitations, design and operation of computers and computer systems, to include computer management, basic computer organization, architecture and operating systems, and computer communications and networks.
3. **ELECTRONIC WARFARE:** The officer will understand the principles of signal processing, communications, radar and electronic warfare, to include analog and digital signals and systems, communications systems analysis, and electronic warfare techniques and systems.
4. **WEAPONS SYSTEMS ASSESSMENT:** The officer will understand the current technical trends in weapons system technologies which may significantly affect warfare, to include nuclear weapons and their effects, nuclear strategic balance, satellite orbits, directed energy weapon concepts, and future weapon concepts.
5. **SPACE SYSTEMS OPERATIONS:** The officer will understand the military applications of space and the capabilities and limitations of spaceborne sensing, to include the principles of active and passive sensors used in spacecraft, the tradeoffs among various sensor techniques, and, an appreciation of the natural and induced environment of space, the atmosphere and ocean on sensing systems.
6. **ANALYTICAL AND RESEARCH METHODS:** The officer will understand analytical and research methods as applied to intelligence.
7. **GENERAL MILITARY INTELLIGENCE:** The officer will understand general military intelligence which provides an intellectual framework for integrating scientific and technical information gained in other non-intelligence courses to intelligence applications, to include: intelligence support to crisis operations; intelligence support to national security policy; intelligence support to security assistance; intelligence monitoring and analysis of arms transfers, technology control and counter-proliferation; and integrated intelligence support to strategic planning.
8. **JOINT AND MARITIME STRATEGIC PLANNING:** American and world military history and joint and maritime planning including the origins and evolution of national and allied strategy; current American and allied military strategies which address the spectrum of conflict; the U.S. maritime component of national military strategy; the organizational structure of the U.S. defense establishment; the role of the commanders of unified and specified commands in strategic planning; joint and service doctrine, and the roles and missions of each in meeting national strategy.

REGIONAL INTELLIGENCE (TRACK 2)

1. **JOINT AND MARITIME STRATEGIC PLANNING:** The officer will understand the development and execution of military strategy and effects of technical developments on warfare and the formulation of U.S. policy, roles of military forces, joint planning, and current issues in defense reorganization.
2. **ANALYTICAL AND RESEARCH METHODS:** The officer will understand the analytical and research methods as applied to intelligence.
3. **GENERAL MILITARY INTELLIGENCE:** The officer will understand the concepts, principles and methods of joint operational intelligence, intelligence support to national security policy, and intelligence support to crisis operations, to include: indications and warning, essential elements of information and collection plans, intelligence watch and battle staff functioning, contingency operations, mission planning, and tasking of non-organic intelligence assets.
4. **AREA OF REGIONAL EMPHASIS:** The officer will understand the political, cultural and security aspects of one of the following regional areas:
 - a. Far East with Japanese, Korean or Chinese language training;
 - b. Middle East with Gulf Arabic or Farsi language training;
 - c. Russia with Russian language training; and
 - d. Latin America with Spanish or Portuguese language training.

Each student takes six courses in their particular area of emphasis.

OPERATIONAL INTELLIGENCE (TRACK 3)

1. **GLOBAL POLITICAL AND SECURITY PROCESSES AND SYSTEMS:** The officer will understand the international security and comparative politics, with special emphasis on U.S. security interests and international policies in the Middle East, Latin America, Russia and the Ukraine, Western Europe and Asia.
2. **AMERICAN NATIONAL SECURITY POLICY:** The officer will understand American national security policy and the role of Congress in military and intelligence programs and processes.
3. **JOINT AND MARITIME STRATEGIC PLANNING:** American and world military history and joint and maritime planning including the origins and evolution of national and allied strategy; current American and allied military strategies which address the entire spectrum of conflict; the U.S. maritime component of national military strategy; the organizational structure of the U.S. defense establishment; the role of the commanders of unified and specified commands in strategic planning; the

process of strategic planning; joint and service doctrine, and the roles and missions of each in meeting national strategy.

4. **ANALYTICAL AND RESEARCH METHODS:** The officer will understand analytical and research methods as applied to intelligence including an introduction to computer systems principles.
5. **GENERAL MILITARY INTELLIGENCE:** The officer will understand general military intelligence to include military and intelligence aspects of trade sanctions, international trade and finance, defense expenditures, embargoes, counter-proliferation, security assistance, arms transfers, and U.S. defense policy. The officer will integrate emerging areas of economic intelligence into the established framework of operational intelligence which will emphasize joint operational intelligence, net assessment, and intelligence support to crisis operations. A thorough understanding of the concepts, principles and methods of all source support to operational commanders across the entire spectrum of conflict, to include: indications and warning, EEIs and collection plans, intelligence watch and battle staff functioning, contingency operations, mission planning and tasking of nonorganic intelligence assets.

NAVAL/MECHANICAL ENGINEERING PROGRAMS

Curricular Officer:

William E. Gray, Jr.

CDR, USN

Code 34

The Mechanical Engineering Building

BLDG-245, Room 115

(408) 656-2033, DSN 878-2033

NAVAL/MECHANICAL ENGINEERING PROGRAMS

CURRICULUM 570

The objective of this program is to provide graduate education, primarily in the field of Mechanical Engineering, to produce graduates with the technical competence to operate and maintain modern warships and naval systems. He or she will be able to participate in technical aspects of naval systems acquisition for technological advances in naval ships and systems. Through emphasis on the design aspect within the program, the graduate will be well prepared to apply these advances in technology to the warships of the future. An original research project resulting in a finished thesis is an integral part of the curriculum. The schedule of classes is arranged to provide time during the final two quarters for concentration in this area of specialization.

REQUIREMENTS FOR ENTRY

A baccalaureate degree or its equivalent is required, preferably in an engineering discipline. A minimum academic profile code (APC) of 323 is required (334 via Engineering Science Curriculum 460). This equates to a minimum grade point average of 2.20, with mathematics through differential and integral calculus and one year of calculus-based physics as non-waiverable requirements. The program is open to naval officers in the rank of LTJG through LCDR in the 11XX/14XX community, equivalent grade officers of other U.S. services and qualified foreign military officers. DoD employees are also eligible.

NAVAL/MECHANICAL ENGINEERING SUBSPECIALTY

Completion of this curriculum qualifies an officer as a Naval/Mechanical Engineering Specialist with a subspecialty code of XX54P. The curriculum sponsor is Naval Sea Systems Command. A limited number of particularly well qualified students may be able to further their education beyond the Master's Degree and seek the degree of Mechanical Engineer and a XX54N Subspecialty Code.

TYPICAL SUBSPECIALTY ASSIGNMENTS

Upon award of the XX54P subspecialty code, the officer becomes eligible for assignment to those billets identified as requiring graduate education in Naval/Mechanical Engineering. Typical of these billets are the following:

Industrial Activities - Shipyard, SUPSHIP, Ship Repair Facility

Mechanical Engineering Instructor, USNA

Hull Repair Officer (Engineering Duty Officer)

Fleet/Type Commander Staff

Board of Inspection and Survey

Propulsion Examining Board

SIMA

Chief Engineer (Ships and Submarines)

ENTRY DATES

Naval Engineering is an eight-quarter course of study for a 11XX officer and a nine-quarter program for a 14XX officer with entry dates in April or October. Those requiring the Engineering Science Curriculum(460), or the 6 week Math/Physics refresher course, will have their time of arrival adjusted as necessary. If further information is needed, contact the Academic Associate or the Curricular Officer.

Curriculum 570

Academic Associate:

Morris Driels, Professor

Code ME/DR, Mechanical Engineering Building, Room 305

(408)656-3383, DSN 878-3383

DEGREE

Requirements for the degree Master of Science in Mechanical Engineering are met as a milestone en route to satisfying the ESR's of the curricular program.

TYPICAL COURSE OF STUDY

Quarter 1

| | | |
|--------|-------|------------------------|
| EC1010 | (1-1) | MATLAB |
| ME2101 | (4-1) | Thermodynamics |
| ME2501 | (3-0) | Statics |
| MA1043 | (2-0) | Matrix Algebra |
| MA1118 | (5-2) | Multivariable Calculus |

Quarter 2

| | | |
|--------|-------|---------------------------------|
| ME2502 | (4-1) | Dynamics |
| ME2601 | (3-2) | Mechanics of Solids I |
| MA2121 | (4-0) | Ordinary Differential Equations |
| AA2440 | (3-2) | Intro to Digital Computation |

Quarter 3

| | | |
|--------|-------|--|
| ME2201 | (3-2) | Introduction to Fluid Dynamics |
| MA3132 | (4-0) | Partial Differential Equations and Integral Transforms |
| MA2049 | (3-0) | Vector Analysis with Applications |
| MS2201 | (3-2) | Materials Science |

Quarter 4

| | | |
|--------|-------|------------------------------|
| ME3150 | (4-2) | Heat Transfer |
| ME3201 | (3-2) | Intermediate Fluid Mechanics |
| MA3232 | (4-1) | Numerical Analysis |
| MS3202 | (3-2) | Failure Analysis |

Quarter 5

| | | |
|--------|-------|-------------------------------------|
| ME3611 | (4-2) | Mechanics of Solids II |
| ME3711 | (4-1) | Design of Machine Elements |
| ME2801 | (3-2) | Introduction to Engineering Systems |
| ME3410 | (2-4) | Mechanical Engineering Laboratory |

Quarter 6

| | | |
|--------|-------|--|
| ME3240 | (3-0) | Reciprocating and Gas Turbine Power Plants |
| ME3241 | (0-3) | Power Plants Laboratory |
| ME3521 | (3-2) | Mechanical Vibrations |
| TS3001 | (3-2) | Fundamentals of Naval Architecture |
| ME3801 | (3-0) | Linear Automatic Controls |
| ME3802 | (0-2) | Controls Laboratory |
| ME4XXX | | Elective |

Quarter 7

| | | |
|--------|-------|--|
| ME3220 | (3-2) | Steam Power, Refrigeration, and Turbomachinery |
| OS3104 | (4-0) | Statistics for Science and Engineering |
| MS3304 | (3-2) | Corrosion and Marine Environmental Degradation |
| MS3606 | (3-2) | Welding and Joining Metallurgy |
| ME4XXX | | Elective |

Quarter 8

| | | |
|--------|-------|-----------------|
| ME0810 | (0-8) | Thesis Research |
| ME0810 | (0-8) | Thesis Research |

| | | |
|--------|-------|-------------------------------------|
| EC2170 | (4-2) | Electrical Engineering Fundamentals |
| ME4XXX | | Elective |

Quarter 9

| | | |
|--------|-------|---|
| EC2270 | (4-2) | Basic Electronics and Electrical Machines |
| ME0810 | (0-8) | Thesis Research |
| ME0810 | (0-8) | Thesis Research |
| NS3252 | (4-0) | Joint and Maritime Strategic Planning |

TOTAL SHIP SYSTEMS ENGINEERING

The objective of this program is to provide a broad-based, design oriented education focusing on the warship as a total engineering system including hull, mechanical, electrical and combat systems. The program is for selected Naval/Mechanical Engineering, Electrical Engineering, and Combat Systems Engineering students and is structured to lead to the MSME, MSEE, or MS in Physics. Some students will also receive the Degree of Mechanical Engineer or Degree of Electrical Engineer in addition to the Master's Degree. Similar programs are available through the Weapons Engineering Program and the Electronic and Computer Program leading to the Mechanical Engineer or Electrical Engineer degrees. Entry to the program is through the standard 533/570/590 curricula.

REQUIREMENTS FOR ENTRY

A baccalaureate degree in an engineering discipline is required, with an APC of 222. Students are expected to be capable of validating several undergraduate courses included in the standard 570 program. The program is open to Naval officers in the rank of LTJG through LCDR in the 11xx/14xx communities.

NAVAL/MECHANICAL ENGINEERING SUBSPECIALTY

Completion of this program will lead to a subspecialty code xx54P or xx54N (or xx55N if entered from the Electronics and Computer Program; xx66P or xx66N from the Combat Systems Science and Technology Program.) The student will also receive an AQD (Additional Qualification Designator) for completion of the TSSE Program.

Typical Jobs in this Subspecialty:

Upon award of the subspecialty code and AQD, the officer would be eligible for assignments typical of the P-Code. The expectation is that the combination of education and experience would lead to individuals qualified for assignment later in their career to more responsible positions in systems design and acquisition in NAVSEA, SPAWAR and OPNAV, and as Program Managers.

ENTRY DATES

Total Ship Systems Engineering is an eleven-quarter program with an entry date of October. If further information is needed, contact the Curricular Officer or the Academic Associate for this curriculum.

Curriculum

Academic Associate:

Morris Driels, Professor
Code ME/Dr, The Mechanical Engineering Bulding, Bldg 245, Room 305.
(408)656-3383, DSN 878-3383

DEGREE

Requirements for the degrees of Mechanical or Electrical Engineer and/or Master of Science in Mechanical or Electrical Engineering or Physics are met as a milestone en route to satisfying the Educational Skill Requirements of the curricular program.

TYPICAL COURSE OF STUDY

Quarter 1

| | | |
|--------|-------|--|
| MA2121 | (4-0) | Ordinary Differential Equations |
| EC2170 | (4-2) | Introduction to Electrical Engineering |
| ME2101 | (4-1) | Engineering Thermodynamics |
| ME2201 | (3-2) | Introduction to Fluid Mechanics |

Quarter 2

| | | |
|--------|-------|--------------------------------|
| MA3132 | (4-0) | Partial Differential Equations |
| ME3521 | (3-2) | Mechanical Vibrations |
| ME3201 | (3-2) | Intermediate Fluid Mechanics |
| ME2601 | (3-2) | Mechanics of Solids I |

Quarter 3

| | | |
|--------|-------|---|
| ME3220 | (3-2) | Auxiliary and Turbomachinery |
| MS2201 | (3-2) | Materials Science and Engineering |
| ME2801 | (3-2) | Introduction to Engineering System Dynamics |
| ME3611 | (4-0) | Mechanics of Solids II |

Quarter 4

| | | |
|--------|-------|--|
| EC2270 | (4-2) | Basic Electronic and Electrical Machines |
| ME3801 | (3-0) | Linear Automatic Controls |
| ME3802 | (0-2) | Controls Laboratory |
| TS3001 | (3-2) | Fundamental Principles of Naval Architecture |
| ME3150 | (4-1) | Heat Transfer |

Quarter 5

| | | |
|--------|-------|---------------------------------|
| TS3000 | (3-2) | Electrical Power Engineering |
| ME3440 | (4-0) | Engineering Analysis |
| ME3711 | (4-1) | Design of Machine Elements |
| MS3202 | (3-2) | Failure Analysis and Prevention |

Quarter 6

| | | |
|--------|-------|--|
| TS3002 | (3-2) | Principles of Ship Design and Case Studies |
| TS3003 | (4-0) | Naval Combat Systems |
| ME3240 | (3-0) | Reciprocating and Gas Turbine Power Plants |
| ME3241 | (0-3) | Power Plants Laboratory |
| OS3104 | (4-0) | Statistics for Science and Engineering |

Quarter 7

| | | |
|--------|-------|--|
| TS4000 | (3-2) | Naval Combat Systems Engineering |
| TS4001 | (2-4) | Integration of Naval Engineering Systems |
| ME3410 | (2-4) | Mechanical Engineering Instrumentation & Measurement Lab |
| ME4XXX | | Elective |

Quarter 8

| | | |
|--------|-------|------------------------------------|
| ME0810 | (0-8) | Thesis Research Experience Tour |
|--------|-------|------------------------------------|

Quarter 9

| | | |
|--------|-------|-------------------------|
| TS4002 | (3-2) | Ship Design Integration |
| ME4XXX | | Elective |
| ME0810 | (0-8) | Thesis Research |
| ME0810 | (0-8) | Thesis Research |

Quarter 10

| | | |
|--------|-------|--------------------------------|
| TS4003 | (2-4) | Total Ship Systems Engineering |
| ME4XXX | | Elective |
| ME0810 | (0-8) | Thesis Research |
| ME0810 | (0-8) | Thesis Research |

Quarter 11

| | | |
|--------|-------|---------------------------------------|
| NS3252 | (4-0) | Joint and Maritime Strategic Planning |
| ME4XXX | | Elective |
| ME0810 | (0-8) | Thesis Research |
| ME0810 | (0-8) | Thesis Research |

EDUCATIONAL SKILL REQUIREMENTS NAVAL/MECHANICAL ENGINEERING CURRICULUM (570)

Officers entering into the Naval Engineering curriculum will be offered the necessary preparatory level courses to enable them to satisfy the equivalent of a baccalaureate degree in Mechanical Engineering. They shall meet, as a minimum, the requirements set forth by the Accreditation Board for Engineering and Technology (ABET).

At the graduate level, the officer will acquire the competence to participate in technical aspects of naval systems research, design, development, maintenance and acquisition. The background to deal with future advances is gained through the emphasis on design and a combination of the core program requirements, specialization and thesis research.

In pursuit of the above, the goal is for each officer to acquire a senior/upper division level physical and analytical understanding of the following topics. It is recognized that all students may not meet all ESR's depending on individual circumstances determined by the curricular officer and the academic associate. However, each student will be exposed to fundamentals in all ESR areas.

1. **THERMODYNAMICS AND HEAT TRANSFER:** Fundamentals of thermodynamics and heat transfer with applications to all marine engineering power cycles as well as propulsion and auxiliary system cycle analysis and design.
2. **FLUID MECHANICS:** Compressible and incompressible flow, both viscous and inviscid, with emphasis on propellers, cavitation, and design of ship-board fluid systems (e.g., fluid machinery, pumps, turbomachinery).
3. **DYNAMICS AND CONTROL:** Kinematic and dynamic analysis of particle, rigid-body and multi-body mechanical systems. Modeling of engineering systems, including examples from mechanical, electrical and hydraulic applications. Feedback control concepts, both classical and modern and their application to the design of ship stabilization systems, weapon direction systems and power plant control. Instrumentation for propulsion system monitoring and control.
4. **STRUCTURAL MECHANICS AND VIBRATION:** Statically determinant and indeterminant structural analysis, stress/strain analysis, buckling and fatigue. Shock and vibration response of marine structures, including surface ships and submarines.
5. **MATERIALS AND FABRICATION:** Metallurgical processes and transformations; analytical approach to failure of materials in Naval Engineering use and a basic understanding of the materials technology associated with welding and marine corrosion; an introduction to the developing fields of composites and superconducting materials.

- 6. COMPUTERS:** A basic understanding of computer system architecture, operating systems (such as UNIX), networking and introduction to engineering software design. Practical experience of structured programming languages (such as FORTRAN, C), and the use of integrated design tools for computational and symbolic manipulation (such as MATLAB and Maple). Use and application of mainframe, workstation and personal computers for the solution of Naval engineering design and analysis tasks.
- 7. MATHEMATICS:** Sufficient mathematics, including integral transforms and numerical analysis, to achieve the desired graduate education.
- 8. DESIGN/SYNTHESIS:** Design synthesis and introduction to optimization techniques, with emphasis on the design of mechanical subsystems and their integration into the ship system.
- 9. ELECTRICAL ENGINEERING:** Electromagnetic and circuit theories, basic knowledge of analog and digital circuits, rotating electrical machinery, static converters, and power distribution systems and multiphased circuits. A basic understanding of automated control systems and their application to mechanical equipment, integrated electrical machinery, electric power transmission and superconductors.
- 10. NAVAL ARCHITECTURE:** Fundamentals of naval architecture including the geometry, hydrostatics and hydrodynamics of monohull floating and submerged structures. Wave and skin friction analysis, power requirements of particular designs. Longitudinal and transverse stability of floating and submerged bodies, hull girder strength requirements. Introduction to seakeeping and survivability principles.
- 11. DECISION MAKING, RELIABILITY ASSESSMENT AND QUALITY CONTROL:** A basic knowledge of concepts and applications for decision making, reliability, prediction and assessment, and quality control. A practical understanding of relevant probability theory including statistical data analysis techniques, probability distribution and characteristics and standard tests. An understanding of Maintenance Engineering concepts such as reliability, maintainability, and availability.
- 12. SPECIALIZATION:** Each officer will also acquire technical competence in one or more of the following areas: THERMAL/FLUID SCIENCES, SOLID AND STRUCTURAL MECHANICS, DYNAMICS AND CONTROLS, MATERIAL SCIENCE, OR TOTAL SHIP SYSTEMS ENGINEERING through additional graduate level courses and their associated prerequisites.
- 13. JOINT AND MARITIME STRATEGIC PLANNING:** American and world military history and joint and maritime planning including the origins and evolution of national and allied strategy; current American and allied military strategies which address the entire spectrum of conflict; the U.S. maritime component of national military strategy; the organizational structure of the U.S. defense establishment; the role of the commanders of unified and specified commands in strategic planning, the process of strategic planning; joint and service doctrine, and the roles and missions of each in meeting national strategy.
- 14. THESIS:** The graduate will demonstrate the ability to conduct independent analysis, and proficiency in presenting the results in writing and orally by means of a thesis and command-oriented briefing appropriate to this curriculum.

OPERATIONS RESEARCH PROGRAMS

Curricular Officer:

Douglas Grau
CDR, USN
Code 30, Glasgow Hall
Room 219
(408) 656-2786
DSN 878-2786
Fax (408) 656-2458

OPERATIONS ANALYSIS CURRICULUM 360

This program provides education in the application of quantitative analyses to operational, tactical and managerial problems. Mathematics, probability, statistics, economics, human factors, physical science and optimization supply the theoretical background for analyzing alternative choices in tactical and strategic warfare, and in planning, budgeting and procurement of systems and forces. The student learns computational methods and develops skills to identify relevant information, formulate decision criteria and select alternatives. This education enhances performance in all duties throughout a military career including operational billets, technical management assignments and policy making positions.

REQUIREMENTS FOR ENTRY

A baccalaureate degree with above-average grades is required. Completion of mathematics through single variable differential and integral calculus with above average grades is considered minimal preparation. A one-year course in college physics is highly desirable. Students lacking these quantitative prerequisites will be accepted in cases where their undergraduate records indicate that they are exceptional students and there are other indicators of potential such as excellent Graduate Record Examination scores, correspondence or extension courses in quantitative subjects and outstanding motivation for the program. An APC of 324 is required.

OPERATIONS ANALYSIS SUBSPECIALTY

Completion of this curriculum qualifies an officer as an Operations Analysis Subspecialist with a subspecialty code of XX42P. The curriculum sponsor is N-81, Office of Chief of Naval Operations, Resource Appraisal Division.

Typical Jobs in this Subspecialty:

Destroyer Squadron Chief Staff Officer
JCS Analyst
Assistant Staff OPS/PLANS: COMCARGRU
BUPERS
OPS Analyst: Naval War College

OPNAV Analyst
Director OPS Research: SACLANT
Staff OPS & PLANS: COMTHIRDFLT
OSD Analyst
Instructor: NPS

ENTRY DATES

Operations Analysis is an eight-quarter course of study with entry dates in March and September. If further information is needed, contact the Academic Associate or the Curricular Officer for this curriculum.

Curriculum 360

Academic Associate:

Glenn F. Lindsay, Associate Professor
Code OR/Ls, Glasgow Hall, Room 289
(408) 656-2688, DSN 878-2688

DEGREE

Requirements for the degree Master of Science in Operations Research are met as a milestone en route to satisfying the Educational Skill Requirements of the curricular program.

TYPICAL COURSE OF STUDY

Quarter 1

| | | |
|--------|-------|--|
| OA2200 | (4-1) | Computational Methods for Operations I |
| MA1118 | (5-2) | Multivariable Calculus |
| MA3042 | (4-0) | Linear Algebra |
| OA3101 | (4-1) | Probability |

Quarter 2

| | | |
|--------|-------|--|
| OA3200 | (4-0) | Computational Methods for Operations Research II |
| MA3110 | (4-0) | Topics in Intermediate Analysis |
| NS3252 | (4-0) | Joint & Maritime Strategic Planning |
| OA3102 | (4-1) | Probability and Statistics |

Quarter 3

| | | |
|--------|-------|---------------------------------|
| OA3201 | (4-0) | Linear Programming |
| OA3401 | (4-0) | Human Factors in Systems Design |
| OA3301 | (4-0) | Stochastic Models I |
| OA3103 | (4-1) | Statistics |

Quarter 4

| | | |
|--------|-------|--------------------------|
| OA4202 | (4-0) | Network Flows and Graphs |
| OA4604 | (4-0) | War Gaming Analysis |
| OA3302 | (4-0) | Simulation |
| OA3104 | (4-1) | Data Analysis |

Quarter 5 (First six weeks)

| | | |
|------------------|-------|---|
| OA4201 | (4-0) | Non-Linear Programming |
| AS3610 | (4-0) | Micro-Economics for Operations Research |
| (Last six weeks) | | Experience Tour Off Campus |

Quarter 6

| | | |
|--------|-------|-----------------------------|
| OA3601 | (4-0) | Combat Model and Games |
| OA3602 | (4-0) | Search Theory and Detection |
| OA4301 | (3-2) | Stochastic Models II |
| OA0810 | (0-8) | Thesis Research |

Quarter 7

| | | |
|--------|-------|---------------------|
| OA4603 | (3-2) | Test and Evaluation |
| OA0810 | (0-8) | Thesis Research |
| OAXXXX | | Elective |
| OA4702 | (4-0) | Cost Estimation |

Quarter 8

| | | |
|--------|-------|-------------------|
| OA4602 | (4-0) | Campaign Analysis |
| OA0810 | (0-8) | Thesis Research |
| OAXXXX | | Elective |
| OAXXXX | | Elective |

OPERATIONAL LOGISTICS CURRICULUM 361

This program provides education in mathematics, probability and statistics, physical science, economics, logistics and computer science. These disciplines supply the theoretical background for analyzing alternative choices in Naval logistics planning, including sustainability of Naval Forces involved in long-range deployments.

The course of study develops skills in computational capability, identifying relevant information, generating decision criteria and selecting alternatives. This education enhances performance in all duties throughout a military career, including operational billets, technical management assignments and policy making positions.

REQUIREMENTS FOR ENTRY

A baccalaureate degree with above-average grades is required. Completion of mathematics through single variable differential and integral calculus with above average grades is considered minimal preparation. A one-year course in college physics is highly desirable. Students lacking these quantitative prerequisites will be accepted in cases where their undergraduate records indicate that they are exceptional students, and there are other indicators of potential, such as excellent Graduate Record Examination scores, correspondence or extension courses in quantitative subjects and outstanding motivation for the program.

OPERATIONAL LOGISTICS SUBSPECIALTY

Completion of this curriculum qualifies an officer as an Operations Logistics Subspecialist with a subspecialty of XX43P. The curriculum sponsor is N-4, Office of Chief of Naval Operations (Logistics).

Typical Jobs in this Subspecialty:

| | |
|---|---------------------------|
| ACOS, SACLANT | LOG, PLANS, CINCUSNAVEUR |
| LOG, PLANS, CINCPACFLT | OPNAV Fleet Mobilization |
| JCS Logistics | Warfare Analyst, NSURFWPC |
| OSD Analyst | USCINPAC Analyst |
| Head Special Studies, Strategic Systems Project Officer | |
| VX-1 Analyst | War College Professor |

ENTRY DATE

Operational Logistics is an eight-quarter course of study with a single entry date in October. If further information is needed, contact the Academic Associate or Curricular Officer for this curriculum.

Curriculum 361

Academic Associate:

David A. Schrady, Professor
Code OR/So, Glasgow Hall, Room 271
(408) 656-2801, DSN 878-2801

DEGREE

Requirements for the degree Master of Science in Operations Research are met as a milestone en route to satisfying the Educational Skill Requirements of the curricular program.

TYPICAL COURSE OF STUDY

Quarter 1

| | | |
|--------|-------|---|
| OA2200 | (4-1) | Computational Methods for Operations Research I |
| MA1118 | (5-2) | Multivariable Calculus |
| MA3042 | (4-0) | Linear Algebra |
| OA3101 | (4-1) | Probability |

Quarter 2

| | | |
|--------|-------|--|
| OA3200 | (4-0) | Computational Methods for Operations Research II |
| MA3110 | (4-0) | Topics in Intermediate Analysis |
| OA3610 | (4-0) | Introduction to Naval Logistics |
| OA3102 | (4-1) | Probability and Statistics |

Quarter 3

| | | |
|--------|-------|-------------------------------|
| OA3201 | (4-0) | Linear Programming |
| MA4376 | (4-0) | Defense Transportation System |
| OA3301 | (4-0) | Stochastic Models I |
| OA3103 | (4-1) | Statistics |

Quarter 4

| | | |
|--------|-------|----------------------------|
| OA4611 | (4-0) | Logistics in Naval Warfare |
| OA3302 | | Simulation |
| OA3104 | (4-1) | Data Analysis |
| OA4202 | (4-0) | Network Flows and Graphs |

Quarter 5 (First six weeks)

| | | |
|------------------|-------|---|
| OA4201 | (4-0) | Non-Linear Programming Systems Simulation |
| AS3610 | (4-0) | Micro Economics for Operations Research |
| (Last six weeks) | | Experience Tour Off Campus |

Quarter 6

| | | |
|--------|-------|------------------------|
| OA3601 | (4-1) | Combat Model and Games |
| OA4301 | (3-2) | Stochastic Models II |
| OA0810 | (0-8) | Thesis Research |
| OA4612 | (4-0) | Logistics Model |

Quarter 7

| | | |
|--------|-------|---------------------------------------|
| OA4604 | (4-0) | Wargaming Analysis |
| OAXXXX | | Elective |
| OA0810 | (0-8) | Thesis Research |
| NS3252 | (4-0) | Joint and Maritime Strategic Planning |

Quarter 8

| | | |
|--------|-------|-------------------|
| OA4602 | (4-0) | Campaign Analysis |
| OA0810 | (0-8) | Thesis Research |
| OA4302 | (4-0) | Reliability |
| OAXXXX | | Elective |

**ADVANCED SCIENCE (APPLIED MATHEMATICS)
CURRICULUM 380**

This program is designed to meet the needs of the Department of Defense for graduates who are skilled in the concepts of higher mathematics. The objective of the program is to equip an officer with the skill to: analyze a military problem; formulate it in mathematical terms; solve or approximate a solution; interpret and present the results.

Completion of this curriculum also qualifies an officer as an Applied Mathematics Subspecialist with a subspecialty code of XX41P. The curriculum sponsor is the U.S. Naval Academy Department of Mathematics. The typical job in this subspecialty is an instructor in mathematics at the U.S. Naval Academy or the U.S. Military Academy at West Point.

REQUIREMENTS FOR ENTRY

Preparatory to graduate work in applied mathematics, the officer shall have completed a strong program of study at the undergraduate level or the first three quarters of the mathematics core sequence, which includes linear algebra, advanced calculus in one and several variables, ordinary differential equations, probability and statistics. Officers not having the required qualifications for direct input enter the program indirectly through the Engineering Science curriculum discussed elsewhere in this catalog. An APC of 324 is required.

ENTRY DATES

Advanced Science (Applied Mathematics) is an eight-quarter course of study with entry dates in any quarter. If further information is needed, contact the Academic Associate or Curricular Officer for this curriculum.

Curriculum 380

Academic Associate:

Maurice D. Weir, Professor

Code MA, Ingersoll Hall, Room 335

(408) 656-2608, DSN 878-2608

DEGREE

Requirements for the degree Master of Science in Mathematics are met as a milestone en route to satisfying the Educational Skill Requirements of the curricular program.

TYPICAL COURSE OF STUDY

Quarter 1

| | | |
|--------|-------|---------------------------------------|
| AE2440 | (3-2) | Introduction to Digital Computing |
| MA1118 | (5-2) | Multivariable Calculus |
| MA2121 | (4-0) | Ordinary Differential Equations |
| NS3252 | (4-0) | Joint and Maritime Strategic Planning |

Quarter 2

| | | |
|--------|-------|--------------------------------|
| MA2025 | (4-1) | Bridge to Advanced Mathematics |
| MA2049 | (3-0) | Vector Analysis |
| MA3042 | (4-0) | Linear Algebra |
| OA3101 | (4-1) | Probabililty |

Quarter 3

| | | |
|--------|-------|--------------------------------|
| MA3110 | (4-0) | Intermediate Analysis |
| MA3132 | (4-0) | Partial Differential Equations |
| MA3232 | (4-1) | Numerical Analysis |
| OA3102 | (4-1) | Probability and Statistics |

Quarter 4

| | | |
|--------|-------|-----------------------------|
| MA3605 | (3-0) | Real Analysis I |
| MA4237 | (4-0) | Advanced Numerical Analysis |
| MA3560 | (3-0) | Modern Applied Algebra |
| OA3103 | (4-1) | Statistics |

Quarter 5

| | | |
|--------|-------|----------------------------------|
| MA3606 | (3-0) | Real Analysis II |
| MAXXXX | | Option Requirement |
| MA3046 | (3-0) | Matrix Theory and Computational |
| MA3400 | (4-0) | Mathematical Modelling Processes |

Quarter 6

| | | |
|--------|-------|----------------------------|
| MAXXXX | | Option Requirement |
| IA4311 | (3-0) | Calculus of Variations |
| IA4391 | (3-0) | Numerical Fluid Dynamics I |
| IA3301 | (4-0) | Linear Programming |

Quarter 7

| | | |
|--------|-------|-----------------------------|
| IAXXXX | | Option Requirement |
| X-XXXX | | Option Requirement |
| IA4392 | (3-0) | Numerical Fluid Dynamics II |
| IA0810 | (0-8) | Thesis Research |

Quarter 8

| | | |
|--------|-------|-----------------------|
| X-XXXX | | Option Requirement |
| IA4103 | (3-0) | Thesis Topics Seminar |
| IA0810 | (0-8) | Thesis Research |
| IA0810 | (0-8) | Thesis Research |

EDUCATIONAL SKILL REQUIREMENTS OPERATIONS ANALYSIS CURRICULUM (360)

1. **BASIC ANALYTICAL SKILLS:** The graduate will possess the skills in higher mathematics required to support graduate study in operations research, have proficiency in computing with mainframe and microcomputer systems, have the ability to program in several languages, and have knowledge of software packages and languages of special importance in performing military operations analysis.
2. **DATA ANALYSIS:** The graduate will possess the skills in probability, statistics, and exploratory data analysis required to formulate and execute analyses involving uncertainty, including analyses of military operations, logistics, and personnel problems; will be proficient in the principles of probability and statistics and the use of one or more statistical graphics programs, and be able to interactively apply a variety of methods to actual data. The graduate will be able to analyze a variety of DoD data sets (reconstructed from operations, collected in the field, generated in the laboratory, etc.) to answer specific operational questions and formally report the results.
3. **OPTIMIZATION:** The graduate will possess a solid framework of understanding of what is technically feasible in the formulation and solution of optimization models of real-world decision problems, and will have thoroughly explored new and traditional applications of optimization to military problems in logistics, manpower planning, weapons assignment, RD&A project selection, mission planning, asset distribution, scheduling, and resource allocation. The graduate will have experienced the complete, from-scratch development of an optimization model for a military decision problem with emphasis on the creation and presentation of results that are useful to commanders with or without analytical background and defendable to technical experts.
4. **STOCHASTIC MODELING:** The graduate will be able to formulate and solve problems involving processes with uncertainty over time, including the ability to apply the theory to naval warfare, tactical decision analysis, target search and detection, operational logistics support, fleet maintenance and repair requirements, and military manpower systems.
5. **WARFARE ANALYSIS:** The graduate will be familiar with U.S./Allied and potential enemy capabilities, doctrine, and tactical concepts and will be able to model and analyze military operations using OR techniques. The graduate will further be able to develop new tactical and logistics concepts based on theory, exercise reconstruction, and analysis.
6. **SYSTEMS ANALYSIS:** The graduate will understand the principles of economic analysis and their application as reflected in DODI 7041.3, and be aware of the theoretical difficulties of extending these principles to the analysis of weapon systems. The graduate will acquire skill with specific measurement tools for military effectiveness and cost, and will apply principles and tools to decisions about tactics, systems and force structure. In particular, the development of cost and effectiveness analyses (COEAs) as required for all new weapons systems by DODI 5000.2M will be practiced.

7. **HUMAN FACTORS:** The graduate will be sufficiently knowledgeable about the human-machine interface to quantitatively link weapon system design features to operator and maintainer performance. By extension the graduate will be able to measure the design's impact on mission capability. Graduates will be able to recognize designs that exploit the strengths and minimize the limitations of people operating combat systems.
8. **INVENTORY:** The graduate will have a working knowledge of the current OR inventory management models of the three military services and of the analytical foundations which led to these models. The graduate will understand which models are appropriate for each phase of the life cycle of a weapon system. The graduate will be able to formulate new variants of these models as required to support the evolving structure of the joint forces.
9. **PRACTICE:** The graduate will have gained experience doing real analytical studies in operations research while on experience tour with an appropriate staff, organization or activity. Further, the graduate will demonstrate the ability to conduct independent analysis in operations research and proficiency in presenting the results in writing and orally by means of a thesis and command-oriented briefing.
10. **JOINT AND MARITIME STRATEGIC PLANNING:** American and world military history and joint and maritime planning including the origins and evolution of national and allied strategy; current American and allied military strategies which address the entire spectrum of conflict; the U.S. maritime component of national military strategy; the organizational structure of the U.S. defense establishment; the role of the commanders of unified and specified commands in strategic planning; the process of strategic planning; joint and service doctrine, and the roles and missions of each in meeting national strategy.

EDUCATIONAL SKILL REQUIREMENTS OPERATIONAL LOGISTICS CURRICULUM (361)

- 1. BASIC ANALYTICAL SKILLS.** The graduate will possess the skills in higher mathematics required to support graduate study in operations research, have proficiency in computing with mainframe and microcomputer systems, have the ability to program in several languages, and have knowledge of software packages and languages of special importance in performing military operations analysis.
- 2. DATA ANALYSIS.** The graduate will possess the skills in probability, statistics, and exploratory data analysis required to formulate and execute analyses involving uncertainty, including analyses of military operations, logistics, and personnel problems; will be proficient in the principles of probability and statistics and the use of one or more statistical graphics programs, and be able to interactively apply a variety of methods to actual data. The graduate will be able to analyze a variety of DoD data sets (reconstructed from operations, collected in the field, generated in the laboratory, etc.) to answer specific operational questions and formally report the results.
- 3. OPTIMIZATION.** The graduate will possess a solid framework of understanding of what is technically feasible in the formulation and solution of optimization models of real-world decision problems, and will have thoroughly explored new and traditional applications of optimization to military problems in logistics, manpower planning, weapons assignment, RD&A project selection, mission planning, asset distribution, scheduling, and resource allocation. The graduate will have experienced the complete, from scratch development of an optimization model for a military decision problem with emphasis on the creation and presentation of results that are useful to commanders with or without analytical background and defensible to technical experts.
- 4. STOCHASTIC MODELING.** The graduate will be able to formulate and solve problems involving processes with uncertainty over time, including the ability to apply the theory to naval warfare, tactical decision analysis, target search and detection, operational logistics support, fleet maintenance and repair requirements, and military manpower systems.
- 5. WARFARE ANALYSIS.** The graduate will be familiar with U.S./Allied and potential enemy capabilities, doctrine, and tactical concepts and will be able to model and analyze military operations using OR techniques. The graduate will further be able to develop new tactical and logistics concepts based on theory, exercise reconstruction, and analysis.
- 6. SYSTEMS ANALYSIS.** The graduate will understand the principles of economic analysis and their application as reflected in DODI 7041.3, and be aware of the theoretical difficulties of extending these principles to the analysis of weapon systems. The graduate will acquire skill with specific measurement tools for military effectiveness and cost, and will apply principles and tools to decisions about tactics, systems and force structure. In particular, the development of cost and effectiveness analyses (COEAs) as required for all new weapons systems by DODI 5000.2M will be practiced.

7. **TRANSPORTATION.** The graduate will have a thorough understanding of defense transportation requirements determination and transportation related planning processes within DoD, the organizations and subsystems that comprise the defense transportation system, the institutional constraints and resource allocation problems related to defense transportation, and current studies and analyses of defense transportation.
8. **LOGISTICS.** The graduate will have gained a thorough understanding of all aspects of the Naval logistics system and of logistics in naval and amphibious warfare. The graduate will understand Navy and Joint planning systems and be able to develop and use logistics planning factors. The graduate will have experience of logistics wargaming, the development and use of operational logistics decision support systems, and the use of analytical methods in developing logistics plans for specific operations or contingencies.
9. **PRACTICE.** The graduate will have gained experience doing real analytical studies in operations research while on experience tour with an appropriate staff, organization or activity. Further, the graduate will demonstrate the ability to conduct independent analysis in operations research and proficiency in presenting the results in writing and orally by means of a thesis and command-oriented briefing.
10. **Joint and Maritime Strategic Planning.** An overview of American and world military history and joint and maritime planning including the origins and evolution of national and allied strategy; current American and allied military strategies which address the entire spectrum of conflict; the U.S. maritime component of national military strategy; the organizational structure of the U.S. defense establishment; the role of the commanders of unified and specified commands in strategic planning; the process of strategic planning; joint and service doctrine, and the roles and missions of each in meeting national strategy.

EDUCATIONAL SKILL REQUIREMENTS

APPLIED MATHEMATICS

CURRICULUM (380)

1. JOINT AND MARITIME STRATEGIC PLANNING: American and world military history and joint and maritime planning including the origins and evolution of national and allied strategy; current American and allied military strategies which address the entire spectrum of conflict; the U.S. maritime component of national military strategy; the organizational structure of the U.S. defense establishment; the role of the commanders of unified and specified commands in strategic planning, the process of strategic planning; joint and service doctrine, and the roles and missions of each in meeting national strategy.

2. BASICS:

- a. A solid foundation in linear algebra, calculus of one and several variables, ordinary differential equations, probability, statistics, discrete mathematics, modern applied algebra, and mathematical modeling to support graduate study in mathematics.
- b. Knowledge of how to use the mainframe, workstation, and microcomputer as a tool to aid in analysis.
- c. Exposure to the basic physical and technological principles underlying a diversity of real-world problems of importance to the military which the student may be called upon to model and analyze.

3. FUNDAMENTAL AREAS: An understanding, at the graduate level, of the following fundamental areas of mathematics:

| | |
|-----------------------|------------------------------------|
| probability | linear algebra and vector analysis |
| algebraic structures | real and complex analysis |
| numerical analysis | ordinary differential equations |
| applied mathematics | partial differential equations |
| mathematical modeling | |

4. APPLICATIONS: Well versed in the applications of mathematics to real-world problems of interest to the military. Areas of application include mechanical and electrical systems, stiffness and buckling of beams and plates in double-hulled ships, space systems and orbital problems, numerical computer problems associated with prediction errors, numerical weather prediction, ship routing, acoustics, wave propagation, nonacoustic ASW, and robotics.

5. COMPUTER SKILLS: A working knowledge of at least one higher level structured computer language and the operating system for a computer which supports that language. Be able to use the computer for numerical and symbolic computation of a wide variety of military and industrial problems, including parallel computing.

6. PRACTICE: Have experience in organizing and presenting mathematical ideas, by oral and written means, to students and faculty. Includes, but is not limited to, the ability to present mathematics to students in a classroom environment. The graduate will demonstrate the ability to conduct independent analysis in applied mathematics and proficiency in presenting the results in writing and orally by means of a thesis and command-oriented briefing.

SYSTEMS MANAGEMENT PROGRAMS

Curricular Officer:

Michael P. Tryon
CDR, SC, USN
Code 36, Ingersoll Hall
Room 219
(408) 656-2537, DSN 878-2537

INFORMATION TECHNOLOGY MANAGEMENT CURRICULUM 370

This curriculum provides officers with the knowledge of information systems technology to include computer and telecommunications systems, software engineering, networked and distributed applications, database management systems and decision support systems in the military services. Students will also gain proficiency in information systems, economics and management necessary for the critical management decisions needed in the development and utilization of complex and evolving computer-based military systems.

Information Technology Management is an interdisciplinary, graduate-level master's program integrating mathematics, accounting, economics, statistics, computer science, information systems, electrical engineering, and management disciplines.

REQUIREMENTS FOR ENTRY

A baccalaureate degree, or the equivalent, with above-average grades in mathematics (including differential and integral calculus) resulting in an APC of at least 325 is required for direct entry. Students lacking these quantitative prerequisites may be acceptable for the program, through a six or twelve week refresher, providing their undergraduate records and/or other indicators of success, such as the GRE (Graduate Record Examination) or GMAT (Graduate Management Admission Test), indicate a capability for graduate level work. A minimum TOEFL of 540 if required (500-539 with supplemental language training). While previous computer, communications or information systems experience is certainly helpful, it is not essential.

INFORMATION TECHNOLOGY MANAGEMENT SUBSPECIALTY

Completion of this curriculum qualifies an officer as an Information Technology Management Subspecialist with a subspecialty code of XX89P. The Curriculum Sponsor is Commander, Naval Computer and Telecommunications Command.

Typical Jobs in this Subspecialty:

Computer Systems Analyst, Naval Computer and Telecommunications Station,
Washington, DC
DP Programs (SNAP), NAVMASSO, San Diego, CA
Research Branch, Naval War College, Newport, RI
Electronics Equipment Research, NOSC, San Diego, CA
DP Plans Officer, Naval Computer and Telecommunications Station, Pearl Harbor, HI
Computer Systems Analyst, Naval Computer and Telecommunications Station,
New Orleans, LA

ENTRY DATES

Information Technology Management is an eight-quarter course of study with entry dates in April and October. Those requiring the six or twelve week refresher will begin study prior to those entry dates. If further information is needed contact the Academic Associate or Curricular Officer for this curriculum.

Curriculum 370

Academic Associate:

Carl Jones, Professor

Code SM/Js, Ingersoll Hall, Room 307

(408) 656-2995, DSN 878-2995

DEGREE

Requirements for the degree Master of Science in Information Technology Management are met as a milestone en route to satisfying the Educational Skill Requirements established by the sponsor for the curricular program.

TYPICAL COURSE OF STUDY

Quarter 1

| | | |
|--------|-------|-------------------------------------|
| CS2970 | (4-1) | Structured Programming with Ada |
| IS2000 | (3-1) | Introduction to Computer Management |
| MN2155 | (4-0) | Accounting for Management |
| OS3105 | (4-0) | Statistical Analysis for Management |

Quarter 2

| | | |
|--------|-------|---|
| CS3030 | (4-0) | Computer Architecture and Operating Systems |
| IS3170 | (4-0) | Economic Evaluation of Information Systems I |
| MN3105 | (4-0) | Organization and Management |
| OS3004 | (5-0) | Operations Research for Computer Systems Managers |

Quarter 3

| | | |
|--------|-------|--|
| EO2413 | (4-2) | Introduction to Communications Systems Engineering |
| IS3171 | (4-0) | Economic Evaluation of Information Systems II |
| IS4183 | (4-1) | Applications of Database Management Systems |
| IS4200 | (4-0) | Systems Analysis and Design |

Quarter 4

| | | |
|--------|-------|---------------------------------------|
| EO3503 | (4-2) | Communications Systems Engineering |
| IS3020 | (4-0) | Software Design |
| IS4185 | (4-1) | Decision Support Systems |
| NS3252 | (4-0) | Joint and Maritime Strategic Planning |

Quarter 5

| | | |
|--------|-------|---|
| IS3112 | (4-0) | DoD Information Technology Management |
| EO3523 | (4-0) | Communications Systems Analysis |
| IS3502 | (4-0) | Computer Networks: Wide Area/Local Area |
| IS4300 | (4-0) | Software Engineering and Management |

Quarter 6

| | | |
|--------|-------|--|
| IS4502 | (4-0) | Telecommunications Networks |
| MN4125 | (4-0) | Managing Planned Change in Complex Organizations |
| ----- | (4-0) | Focus Area Choice |
| IS4925 | (4-0) | Seminar on Information Systems Research Methods |

Quarter 7

| | | |
|--------|-------|--|
| CS4601 | (4-0) | Computer Security |
| MN3307 | (4-0) | ADP Acquisition |
| MN3154 | (4-0) | Financial Management in the Armed Forces |
| IS0810 | (0-8) | Thesis Research |

Quarter 8

| | | |
|--------|--------|--------------------------------|
| IS4182 | (4-0) | Information Systems Management |
| IS0810 | (0-16) | Thesis Research |
| ----- | (4-0) | Focus Area Choice (see note) |

NOTE: Students with a strong education and background in any of the above topics can request validation of those courses and thereby avail themselves of additional course work. Typical courses include, but are not limited to:

| | |
|--------|---|
| CC4750 | Military Communications for C4I Systems |
| CS3310 | Artificial Intelligence |
| CS4202 | Computer Graphics |
| IS3000 | Distributed Computer Systems |
| IS3100 | Analysis of Microcomputers and Microprocessors |
| IS3503 | Microcomputer Networks |
| IS4184 | Information Resource Management in DoN/DoD |
| IS4186 | Introduction to Knowledge-Based Systems and Artificial Intelligence |
| IS4800 | Directed Study in Advanced Information Systems |
| MN3374 | Production Management: A TQM/L Perspective |
| MN4105 | Management Policy |
| MN4151 | Internal Control and Auditing |
| MR2419 | Atmospheric Factors in C3 |
| OS3404 | Man-Machine Interaction |

CURRICULUM 813

This curriculum is an interdisciplinary program which integrates mathematics, accounting, economics, behavioral science, management theory, operations/systems analysis and a subspecialty concentration into an understanding of the process by which the defense mission is accomplished. Inputs from the Navy are from the Supply Corps. The programs is designed to provide the officer with fundamental interdisciplinary techniques of quantitative problem-solving methods, behavioral and management science, economic analysis, and financial management; furthermore, it is intended to provide the officer with a Navy/Defense Systems-oriented graduate management education and to provide the officer with the specific functional skills required to effectively manage in this subspecialty area.

REQUIREMENTS FOR ENTRY

A baccalaureate degree with above-average grades is required. Completion of at least two semesters of college algebra or trigonometry is considered to be the minimum mathematical preparation. An APC of 345 is required for entry.

Supply Corps Officers from the U.S. Navy start the curriculum with widely varied academic backgrounds. Each student's prior academic work and related military experience is evaluated for courses previously completed and applicable to the student's curriculum so that academic credits may be transferred. Validation or credit by examination is encouraged.

TRANSPORTATION LOGISTICS MANAGEMENT SUBSPECIALTY

Completion of this curriculum qualifies a naval officer as a Material Movement Subspecialist, subspecialty code 1304P. The Curriculum Sponsor is Naval Supply Systems Command Headquarters.

Typical Jobs in this Subspecialty:

- Transportation Officer: CINCLANTFLT
- Transportation Director: Fleet and Industrial Support Center (FISC) Norfolk, VA.
- Air Terminal Coordinator: COMFAIRMED
- Cargo Handling Officer, Operations Officer: NAVCHAPRU
- CO and XO: NAVMTO
- Deputy Commander: MTMC

ENTRY DATE

Transportation Logistics Management is a seven-quarter course of study with a single entry date in July. If further information is needed, contact the Academic Associate for this curriculum or the Curricular Officer.

Curriculum 813

Academic Associate:

Alan W. McMasters, Professor
Code SM/Mg, Ingersoll Hall, Room 209
(408) 656-2678, DSN 878-2678

DEGREE

Requirements for the degree Master of Science in Management are met as a milestone en route to satisfying the Educational Skill Requirements of the curricular program.

TYPICAL COURSE OF STUDY

Quarter 1

| | | |
|--------|-------|---------------------------------|
| MN2150 | (4-0) | Financial Accounting |
| MN2031 | (4-0) | Economic Decision Making |
| MN3333 | (4-0) | Managerial Communication Skills |
| MA2300 | (5-0) | Mathematics for Management |
| IS0123 | (0-2) | Computer Skills Development |

Quarter 2

| | | |
|--------|-------|-------------------------------------|
| MN3161 | (4-0) | Managerial Accounting |
| MN3140 | (4-0) | Microeconomic Theory |
| MN3373 | (4-0) | Domestic Transportation Management |
| OS3101 | (4-1) | Statistical Analysis for Management |

Quarter 3

| | | |
|--------|-------|---|
| MN3105 | (4-0) | Organization and Management |
| MN3172 | (4-0) | Public Policy and Budgeting |
| MN4373 | (4-0) | International Transportation Management |
| OS3006 | (4-0) | Operations Research for Management |

Quarter 4

| | | |
|--------|-------|--|
| IS3183 | (4-0) | Management Information Systems |
| MN4145 | (4-0) | Policy Analysis |
| MN4376 | (4-0) | Defense Transportation System |
| MN3154 | (4-0) | Financial Management in the Armed Forces |
| MN3221 | (2-0) | Principles of Program Management I |

Quarter 5

| | | |
|--------|-------|-------------------------------------|
| MN0810 | (0-8) | Thesis Research |
| MN3377 | (4-0) | Inventory Management |
| MN3222 | (3-2) | Principles of Project Management II |
| MN3372 | (4-0) | Material Logistics |

Quarter 6

| | | |
|--------|--------|---|
| MN0810 | (0-16) | Thesis Research |
| NS3252 | (4-0) | Joint and Maritime Strategic Planning |
| MN3371 | (4-0) | Contracts Management and Administration |

Quarter 7

| | | |
|--------|-------|-----------------------------------|
| MN0810 | (0-8) | Thesis Research |
| MN4105 | (4-0) | Strategic Management |
| OA3610 | (4-0) | Introduction to Naval Logistics |
| MN3375 | (4-0) | Materials Handling Systems Design |

TRANSPORTATION MANAGEMENT CURRICULUM 814

The objectives of this curriculum are to prepare officers for naval logistics system positions, emphasizing worldwide transportation aspects. Graduate logistics courses cover topics such as the transportation system within CONUS, warehouse siting, materials management, production management, inventory management (both Navy and private sector), materials handling, purchasing and physical distribution. Students take additional courses in transportation in the private sector and military transportation in support of contingencies, as well as, options in corporate financial management, production management, or logistics engineering.

REQUIREMENTS FOR ENTRY

A baccalaureate degree with above-average grades is required. Completion of at least two semesters of college algebra or trigonometry is considered to be the minimum mathematical preparation. An APC of 345 is required for entry.

Officers from the U.S. Services, as well as all others, start the curriculum with widely varied academic backgrounds. Each student's prior academic work and related military experience is evaluated for courses previously completed and applicable to the student's curriculum so that academic credits may be transferred. Validation or credit by examination is encouraged.

TRANSPORTATION MANAGEMENT SUBSPECIALTY

Completion of this curriculum qualifies an officer as a Transportation Management Subspecialist with a subspecialty code of XX35P. The Curriculum Sponsor is The Navy Military Sealift Command Headquarters.

Typical Jobs in this Subspecialty:

Commander: MSCO, COMSCEUR, COMSCMED, COMSCPAC, United Kingdom and
Northen Europe
Tanker Control Officer: Military Sealift Command (MSC) Headquarters
Commander and Deputy Commander: Military Sealift Command Officer (MSCO),
Norfolk, VA

ENTRY DATE

Transportation Management is a seven-quarter course of study with a single entry date in July. If further information is needed, contact the Academic Associate for this curriculum or the Curricular Officer.

Curriculum 814

Academic Associate:

Alan W. McMasters, Professor
Code SM/Mg, Ingersoll Hall, Room 209
(408) 656-2678, DSN 878-2678

DEGREE

Requirements for the degree Master of Science in Management are met as a milestone en route to satisfying the Educational Skill Requirements of the curricular program.

TYPICAL COURSE OF STUDY

Quarter 1

| | | |
|--------|-------|---------------------------------|
| MN2150 | (4-0) | Financial Accounting |
| MN2031 | (4-0) | Economic Decision Making |
| MN3333 | (4-0) | Managerial Communication Skills |
| MA2300 | (5-0) | Mathematics for Management |
| IS0123 | (0-2) | Computer Skills Development |

Quarter 2

| | | |
|--------|-------|-----------------------|
| MN3161 | (4-0) | Managerial Accounting |
|--------|-------|-----------------------|

| | | |
|--------|-------|-------------------------------------|
| MN3140 | (4-0) | Microeconomic Theory |
| MN3373 | (4-0) | Domestic Transportation Management |
| OS3101 | (4-1) | Statistical Analysis for Management |

Quarter 3

| | | |
|--------|-------|---|
| MN3105 | (4-0) | Organization and Management |
| MN3172 | (4-0) | Public Policy and Budgeting |
| MN4373 | (4-0) | International Transportation Management |
| OS3006 | (4-0) | Operations Research for Management |

Quarter 4

| | | |
|--------|-------|--|
| IS3183 | (4-0) | Management Information Systems |
| MN4145 | (4-0) | Policy Analysis |
| MN4376 | (4-0) | Defense Transportation System |
| MN3154 | (4-0) | Financial Management in the Armed Forces |

Quarter 5

| | | |
|--------|-------|--|
| MN0810 | (0-8) | Thesis Research |
| MN3301 | (4-0) | Systems Acquisition and Project Management |
| MN3372 | (4-0) | Material Logistics |

Quarter 6

| | | |
|--------|--------|---|
| MN0810 | (0-16) | Thesis Research |
| MN3111 | (4-0) | Personnel Management Processes |
| MN3371 | (4-0) | Contracts Management and Administration |
| NS3252 | (4-0) | Joint and Maritime Strategic Planning |

Quarter 7

| | | |
|--------|-------|-----------------------------------|
| MN0810 | (0-8) | Thesis Research |
| MN3375 | (4-0) | Materials Handling Systems Design |
| MN4105 | (4-0) | Strategic Management |
| MN4999 | (4-0) | Curriculum Option* |

*Students select option from the following courses:

| | |
|--------|---------------------------------|
| MN3374 | Production Management |
| MN4310 | Logistics Engineering |
| OA3610 | Introduction to Naval Logistics |
| OA4611 | Logistics in Naval Warfare |

ACQUISITION AND CONTRACT MANAGEMENT CURRICULUM 815

The Acquisition and Contract Management Curriculum is an interdisciplinary program which integrates mathematics, accounting, economics, finance, behavioral science, management theory, operations/systems analysis and specific courses in acquisition and contracting. Student input includes officers and civilians from all DoD services, the Coast Guard and other nations. The curriculum is designed to provide officers and civilians with the skills to serve effectively in hardware systems buying offices, field contracting offices, contract administration offices and contracting policy offices.

REQUIREMENTS FOR ENTRY

A baccalaureate degree with above-average grades is required. Completion of at least two semesters of college algebra or trigonometry is considered to be the minimum mathematical preparation. An APC of 345 is required for entry, as is a minimum TOEFL score of 540 (500-539 with supplemental language training) for international students.

Officers from the U.S. Services, as well as all others, start the curriculum with widely varied academic backgrounds. Each student's prior academic work and related military experience is evaluated for courses previously completed and applicable to the student's

curriculum so that academic credits may be transferred. Validation or credit by examination is encouraged.

ACQUISITION AND CONTRACT MANAGEMENT SUBSPECIALTY

Completion of this curriculum qualifies Naval officers as Acquisition and Contract Management Subspecialists with a subspecialty code of 1306P, Army officers as Functional Area 97, and Marine Corps officers with a 9656 MOS. The Curriculum Sponsor is the Deputy to the Assistant Secretary of the Navy (Research, Development and Acquisition) for Acquisition Policy, Integrity and Accountability. The curriculum satisfies the mandatory Defense Acquisition University (DAU) contracting courses required by the Defense Acquisition Workforce Improvement Act (DAWIA).

Typical Jobs in this Subspecialty:

Contracting Officer:

- Ships Parts Control Center, Mechanicsburg, PA;
- Aviation Supply Office, Philadelphia, PA

Director of Contracts:

- Marine Corps Field Contracting System, Fleet and Industrial Supply Centers, Army and Navy Laboratories, Naval Regional Contracting Centers

Procuring Contracting Officer, (PCO):

- Hardware Systems Commands(NAVAIR, NAVSEA, SPAWAR), Washington, DC
- Army Material Command
- Major Subordinate Commands (e.g. ATCOM, MICOM, TACOM)

Business/Financial Manager (B/FM):

- Hardware Systems Commands (NAVAIR, NAVSEA, SPAWAR), Washington, DC

Contracts and Business Policy:

- Staff of Assistant Secretary of the Navy (Research, Development and Acquisition)

Acquisition)
Staff of Assistant Secretary of the Army (Research, Development and Acquisition)

- Staff of Under Secretary of Defense (Acquisition & Technology)

Administrative Contracting Officer (ACO):

- Defense Contract Management Command (DCMC)
- Superintendent, Shipbuilding, Conversion and Repair (SUPSHIP)

ENTRY DATES

Acquisition and Contract Management is a six-quarter course of study with entry dates in January and July. If further information is needed, contact the Academic Associate for this curriculum or the Curricular Officer.

Curriculum 815

Academic Associate:

David V. Lamm, Associate Professor
Code SM/Lt, Ingersoll Hall, Room 248
(408) 656-2775, DSN 878-2775

DEGREE

Requirements for the degree Master of Science in Management are met as a milestone en route to satisfying the Educational Skill Requirements of the curricular program.

TYPICAL COURSE OF STUDY

Quarter 1

| | | |
|--------|-------|---|
| MN2150 | (4-0) | Financial Accounting |
| MN2031 | (4-0) | Economic Decision Making |
| MN3333 | (4-0) | Managerial Communication Skills |
| MA2300 | (5-0) | Mathematics for Management |
| MN2302 | (0-2) | Seminar for Contracting Students |
| IS0123 | (0-2) | Computer Skills Development (as required) |

Quarter 2

| | | |
|--------|-------|---|
| MN3303 | (4-0) | Principles of Acquisition and Contracting |
| MN3140 | (4-0) | Microeconomic Theory |
| MN3161 | (4-0) | Management Accounting |
| OS3101 | (4-1) | Statistical Analysis for Management |
| MN2302 | (0-2) | Seminar for Contracting Students |

Quarter 3

| | | |
|--------|-------|---------------------------------------|
| MN3304 | (5-2) | Contract Pricing and Negotiations |
| MN3312 | (3-0) | Contract Law |
| NS3252 | (4-0) | Joint and Maritime Strategic Planning |
| MN3105 | (4-0) | Organization and Management |
| MN2302 | (0-2) | Seminar for Contracting Students |

Quarter 4

| | | |
|--------|-------|----------------------------------|
| MN3305 | (3-0) | Contract Administration |
| MN3306 | (3-0) | Acquisition Management |
| MN4145 | (4-0) | Policy Analysis |
| IS3183 | (4-0) | Management Information Systems |
| MN3172 | (4-0) | Public Policy and Budgeting |
| MN2302 | (0-2) | Seminar for Contracting Students |

Quarter 5

| | | |
|--------|-------|------------------------------------|
| MN4301 | (4-0) | Contracting for Major Systems |
| MN0810 | (0-8) | Thesis Research |
| MN0810 | (0-8) | Thesis Research |
| OS3006 | (4-0) | Operations Research for Management |
| MN2302 | (0-2) | Seminar for Contracting Students |

Quarter 6

| | | |
|--------|-------|------------------------------------|
| MN4371 | (4-0) | Acquisition and Contracting Policy |
| MN4105 | (4-0) | Strategic Management |
| MN0810 | (0-8) | Thesis Research |
| MN2302 | (0-2) | Seminar for Contracting Students |
| MN4999 | (4-0) | Curriculum Option* |

*One additional course must be selected from the following curriculum options:

| | |
|--------|--|
| MN3154 | Financial Management in the Armed Forces |
| MN3374 | Production Management |
| MN4151 | Internal Control and Financial Auditing |
| MN4152 | Corporate Financial Management |
| MN4162 | Cost Accounting |
| MN4302 | Defense Resource Policy Management |
| MN4305 | Defense Technology Policy |
| MN4310 | Logistics Engineering |
| MN4372 | Seminar in Acquisition and Contract Management |

SYSTEMS ACQUISITION MANAGEMENT CURRICULUM 816

The Systems Acquisition Management Curriculum is an interdisciplinary program designed to integrate business principles, management theory, operations/systems analysis, and engineering applications. It is uniquely tailored to Defense acquisition management and intensive exposure to the fundamental principles of the acquisition environment. The courses in this curriculum present the structure of acquisition management, the decisions and problems facing the defense acquisition manager, the various forces at work within industry and Government, and the impact of acquisition policies and strategies. Student input includes officers and civilians from all DoD Services, the Coast Guard and other nations.

REQUIREMENTS FOR ENTRY

A baccalaureate degree with above-average grades is required. Completion of at least two semesters of college algebra or trigonometry is considered to be the minimum mathematical preparation. An APC of 345 is required for entry, as is a TOEFL minimum score of 540 (500-539 with supplemental language training) for international students.

Officers from the U.S. Services, international officers and DoD civilian employees enter the curriculum with widely varied academic backgrounds. Each student's prior academic work and related experience is evaluated for courses previously completed and applicable to the student's curriculum so that academic credit may be transferred. Validation or credit by examination is encouraged where knowledge of the material has been acquired by experience or Service courses.

SYSTEMS ACQUISITION MANAGEMENT SUBSPECIALTY

Completion of this curriculum qualifies an Army officer for Functional Areas 51 and 97 and a Marine Corps officer for MOS 9657. Department of Defense civilians are typically members of the acquisition workforce as specified by the Defense Acquisition Workforce Improvement Act (DAWIA). This curriculum satisfies the mandatory requirements for the Program Management Course (PMC) (PMT301 and PMT302) at the Defense Systems Management College (DSMC). The Curriculum Sponsor is the Military Deputy to the Assistant Secretary of the Army (Research, Development and Acquisition).

Typical Jobs in this Subspecialty:

Program Manager/Deputy Program Manager

Army/Navy/Marine Corps Aircraft, Missile, Vehicle and Ship programs

Class Desk Officer

Naval Air Systems Command

Program Executive Officer (PEO) staff

Matrix Organization staff

Army Aviation Troop Command

Naval Air Systems Command

Naval Sea Systems Command

Army Missile Command

Army Communications and Electronics Command

Marine Corps Systems Command

Test and Evaluation Officer

Logistics Officer

Marine Corps Logistics Base

ENTRY DATES

Systems Acquisition Management is a seven-quarter course of study (eight quarters for U.S. Army Officers) with entry dates in January and July. If further information is needed, contact the Academic Associate for this curriculum or the Curricular Officer.

Curriculum 816

Academic Associate:

David V. Lamm, Associate Professor

Code SM/Lt, Ingersoll Hall, Room 248

(408)656-2775, DSN 878-2775

DEGREE

Requirements for the degree Master of Science in Management are met as a milestone en route to satisfying the Educational Skill Requirements of the curricular program.

TYPICAL COURSE OF STUDY (All students except U.S. Army Officers)

Quarter 1

MN2150 (4-0) Financial Accounting

| | | |
|--------|-------|---|
| MN2031 | (4-0) | Economic Decision Making |
| MN3333 | (4-0) | Managerial Communication Skills |
| MA2300 | (5-0) | Mathematics for Management |
| MN2303 | (0-2) | Seminar for Program Management Students |
| IS0123 | (0-2) | Computer Skills Development (as required) |

Quarter 2

| | | |
|--------|-------|--|
| MN3161 | (4-0) | Management Accounting |
| MN3140 | (4-0) | Microeconomic Theory |
| MN3301 | (4-0) | Systems Acquisition and Program Management |
| OS3105 | (4-0) | Statistical Analysis for Management |
| MN2303 | (0-2) | Seminar for Program Management Students |

Quarter 3

| | | |
|--------|-------|---|
| MN3105 | (4-0) | Organization and Management |
| MN3371 | (4-0) | Contracts Management and Administration |
| IS3183 | (4-0) | Management Information Systems |
| OS3006 | (4-0) | Operations Research for Management Students |
| MN2303 | (0-2) | Seminar for Program Management Students |

Quarter 4

| | | |
|--------|-------|---|
| MN4310 | (4-0) | Logistics Engineering |
| MN4145 | (4-0) | Policy Analysis |
| MN3309 | (4-0) | Acquisition of Embedded Weapon Systems Software |
| MN3154 | (4-0) | Financial Management in the Armed Forces |
| MN2303 | (0-2) | Seminar for Program Management Students |

Quarter 5

| | | |
|--------|-------|---|
| MN3172 | (4-0) | Public Policy and Budgeting |
| OS3302 | (4-0) | Quality Assurance and Reliability Methods |
| MN4999 | (4-0) | Curriculum Option* |
| MN0810 | (0-8) | Thesis Research |
| MN2303 | (0-2) | Seminar for Program Management Students |

Quarter 6

| | | |
|--------|-------|--|
| OS4601 | (4-0) | Test and Evaluation |
| NS3252 | (4-0) | Joint and Maritime Strategic Planning |
| EO4011 | (3-1) | Systems Engineering for Acquisition Managers |
| MN0810 | (0-8) | Thesis Research |
| MN3311 | (1-2) | Program Management Exercise |

Quarter 7

| | | |
|--------|-------|---|
| MN4307 | (4-0) | Program Management Policy and Control |
| MN4105 | (4-0) | Strategic Management |
| MN0810 | (0-8) | Thesis Research |
| MN0810 | (0-8) | Thesis Research |
| MN2303 | (0-2) | Seminar for Program Management Students |

*One additional course must be selected from the following curriculum options:

| | |
|--------|--|
| IS3020 | Software Design |
| MN3111 | Personnel Management Processes |
| MN3307 | ADP Acquisition |
| MN3374 | Production Management |
| MN3801 | Technology Transfer |
| MN4302 | Defense Resource Policy Management |
| MN4305 | Defense Technology Policy |
| MN4372 | Seminar in Acquisition and Contract Management |
| MN4942 | The Structure, Conduct and Performance of the Defense Industries |

| | |
|--------|-------------------------------------|
| OA4702 | Cost Estimation |
| OS3401 | Human Factors Engineering |
| OS3702 | Manpower Requirements Determination |

TYPICAL COURSE OF STUDY (U.S. Army Officers)

Quarter 1

| | | |
|--------|-------|---|
| MN2150 | (4-0) | Financial Accounting |
| MN2031 | (4-0) | Economic Decision Making |
| MN3333 | (4-0) | Managerial Communication Skills |
| MA2300 | (5-0) | Mathematics for Management |
| MN2303 | (0-2) | Seminar for Program Management Students |

Quarter 2

| | | |
|--------|-------|--|
| MN3161 | (4-0) | Management Accounting |
| MN3140 | (4-0) | Microeconomic Theory |
| MN3301 | (4-0) | Systems Acquisition and Program Management |
| OS3105 | (4-0) | Statistical Analysis for Management |
| MN2303 | (0-2) | Seminar for Program Management Students |

Quarter 3

| | | |
|--------|-------|---|
| MN3105 | (4-0) | Organization and Management |
| IS3183 | (4-0) | Management Information Systems |
| OS3006 | (4-0) | Operations Research for Management Students |
| MN2303 | (0-2) | Seminar for Program Management Students |
| NS3252 | (4-0) | Joint and Maritime Strategic Planning |

Quarter 4

| | | |
|--------|-------|---|
| MN4310 | (4-0) | Logistics Engineering |
| MN3309 | (4-0) | Acquisition of Embedded Weapon Systems Software |
| MN3154 | (4-0) | Financial Management in the Armed Forces |
| MN2303 | (0-2) | Seminar for Program Management Students |
| MN3303 | (4-0) | Principles of Acquisition and Contracting |

Quarter 5

| | | |
|--------|-------|---|
| MN3172 | (4-0) | Public Policy and Budgeting |
| OS3302 | (4-0) | Quality Assurance and Reliability Methods |
| MN3304 | (5-2) | Contract Pricing and Negotiations |
| MN3312 | (3-0) | Contract Law |
| MN2303 | (0-2) | Seminar for Program Management Students |

Quarter 6

| | | |
|--------|-------|--|
| OS4601 | (4-0) | Test and Evaluation |
| OS4011 | (3-1) | Systems Engineering for Acquisition Managers |
| IN3311 | (1-2) | Program Management Exercise |
| IN4145 | (4-0) | Policy Analysis |
| IN3305 | (3-0) | Contract Administration |
| IN3306 | (3-0) | Acquisition Management |

Quarter 7

| | | |
|--------|-------|---|
| IN4301 | (4-0) | Contracting for Major Systems |
| IN4307 | (4-0) | Program Management Policy and Control |
| IN0810 | (0-8) | Thesis Research |
| IN0810 | (0-8) | Thesis Research |
| IN2303 | (0-2) | Seminar for Program Management Students |

Quarter 8

| | | |
|--------|-------|------------------------------------|
| IN4371 | (4-0) | Acquisition and Contracting Policy |
| IN4105 | (4-0) | Strategic Management |
| IN2302 | (0-2) | Seminar for Contracting Students |

| | | |
|--------|-------|-----------------|
| MN0810 | (0-8) | Thesis Research |
| MN0810 | (0-8) | Thesis Research |

SYSTEMS MANAGEMENT CURRICULUM 817

These programs provide officers with the fundamental interdisciplinary techniques of quantitative problem-solving methods, behavioral and management science, economic analysis, and financial management. The curricula educate students to evaluate others' research and analysis and to develop in them sound management and leadership skills.

These curricula are interdisciplinary programs which integrate mathematics, accounting, economics, behavioral science, management theory, operations/systems analysis and a subspecialty concentration area into an understanding of the process by which the defense mission is accomplished. Specialty concentration areas are determined after consultation with the Academic Associate.

REQUIREMENT FOR ENTRY

A baccalaureate degree with above-average grades is required. Completion of at least two semesters of college algebra or trigonometry is considered to be the minimum mathematical preparation. An APC of 345 is required for entry.

Officers from the U.S. Services, and DoD employees, start the curriculum with widely varied academic backgrounds. Each student's prior academic work and related military and civilian experiences are evaluated for courses previously completed and applicable to the student's curriculum so that academic credits may be transferred. Validation or credit by examination is encouraged.

ENTRY DATES

The 817 curricula for USCG, USMC and DoD civilians are six-quarter courses of study with entry dates in January and July. If further information is needed, contact the Academic Associates for these curricula or the Curricular Officer.

Curriculum 817

Academic Associate:

USCG and DoD Civilians - Systems Management

USMC - Defense Systems Analysis

James E. Suchan, Associate Professor
Code SM/Sa, Ingersoll Hall, Room 215A
(408) 656-2905, DSN 878-2905

DEGREE

Requirements for the degree Master of Science in Management are met as a milestone en route to satisfying the Educational Skill Requirements of the curricular program.

TYPICAL COURSE OF STUDY

COAST GUARD

Quarter 1

| | | |
|--------|-------|---------------------------------|
| MN2150 | (4-0) | Financial Accounting |
| MN2031 | (4-0) | Economic Decision Making |
| MN3333 | (4-0) | Managerial Communication Skills |
| MA2300 | (5-0) | Mathematics for Management |
| IS0123 | (0-2) | Computer Skills Development |

Quarter 2

| | | |
|--------|-------|-------------------------------------|
| MN3161 | (4-0) | Managerial Accounting |
| MN3140 | (4-0) | Microeconomic Theory |
| MN3105 | (3-1) | Organization and Management |
| OS3101 | (4-0) | Statistical Analysis for Management |
| MN3902 | (0-2) | MPT Computer Skills |

Quarter 3

| | | |
|--------|-------|--------------------------------------|
| MN3111 | (4-0) | Personnel Management Processes |
| MN3172 | (4-0) | Public Policy and Budgeting |
| MN4161 | (4-0) | Financial Management Control Systems |
| MN4110 | (4-2) | Multivariate Analysis 1 |

Quarter 4

| | | |
|--------|-------|------------------------------------|
| MN4999 | | Curriculum Option* |
| MN4145 | (4-0) | Policy Analysis |
| IS3183 | (4-0) | Management Information Systems |
| OS3006 | (4-0) | Operations Research for Management |

Quarter 5

| | | |
|--------|-------|---------------------------------------|
| MN0810 | (0-8) | Thesis Research |
| MN0810 | (0-8) | Thesis Research |
| MN4999 | | Curriculum Option* |
| NS3252 | (4-0) | Joint and Maritime Strategic Planning |

Quarter 6

| | | |
|--------|-------|----------------------|
| MN0810 | (0-8) | Thesis Research |
| MN4999 | | Curriculum Option* |
| MN4105 | (4-0) | Strategic Management |
| MN4999 | | Curriculum Option* |

MARINE CORPS**Quarter 1**

| | | |
|--------|-------|---------------------------------|
| MN2150 | (4-0) | Financial Accounting |
| MN2031 | (4-0) | Economic Decision Making |
| MN3333 | (4-0) | Managerial Communication Skills |
| MA2300 | (5-0) | Mathematics for Management |
| IS0123 | (0-2) | Computer Skills Development |

Quarter 2

| | | |
|--------|-------|-------------------------------------|
| MN3161 | (4-0) | Managerial Accounting |
| MN3140 | (4-0) | Microeconomic Theory |
| MN3105 | (4-0) | Organization and Management |
| OS3101 | (4-1) | Statistical Analysis for Management |

Quarter 3

| | | |
|--------|-------|--|
| MN3172 | (4-0) | Public Policy and Budgeting |
| MN3301 | (4-0) | Systems Acquisition and Project Management |
| OS3006 | (4-0) | Operations Research for Management |
| MN3154 | (4-0) | Financial Management in the Armed Forces |

Quarter 4

| | | |
|--------|-------|--|
| OA4702 | (4-0) | Cost Estimation |
| MN4145 | (4-0) | Policy Analysis |
| IS3183 | (4-0) | Management Information Systems |
| MN4163 | (4-0) | Analytical Techniques for Financial Control & Planning |

Quarter 5

| | | |
|--------|-------|-------------------------------------|
| MN0810 | (0-8) | Thesis Research |
| MN0810 | (0-8) | Thesis Research |
| MN4999 | | Curriculum Option* |
| NS3252 | (4-0) | Joint & Maritime Strategic Planning |

Quarter 6

| | | |
|--------|-------|----------------------|
| MN0810 | (0-8) | Thesis Research |
| MN4105 | (4-0) | Strategic Management |

| | | |
|--------|-------|--------------------|
| MN4999 | | Curriculum Option* |
| MN4999 | (4-0) | Curriculum Option* |

DoD CIVILIAN PROGRAM

Quarter 1

| | | |
|--------|-------|---------------------------------|
| MN2150 | (4-0) | Financial Accounting |
| MN2031 | (4-0) | Economic Decision Making |
| MN3333 | (4-0) | Managerial Communication Skills |
| MA2300 | (5-0) | Mathematics for Management |
| IS0123 | (0-2) | Computer Skills Development |

Quarter 2

| | | |
|--------|-------|-------------------------------------|
| MN3161 | (4-0) | Managerial Accounting |
| MN3140 | (4-0) | Microeconomic Theory |
| MN3105 | (4-0) | Organization and Management |
| OS3101 | (4-1) | Statistical Analysis for Management |

Quarter 3

| | | |
|--------|-------|------------------------------------|
| MN4999 | | Curriculum Option* |
| MN3172 | (4-0) | Public Policy and Budgeting |
| MN4999 | | Curriculum Option* |
| OS3006 | (4-0) | Operations Research for Management |

Quarter 4

| | | |
|--------|-------|--------------------------------|
| MN4999 | | Curriculum Option* |
| MN4145 | (4-0) | Policy Analysis |
| IS3183 | (4-0) | Management Information Systems |
| MN4999 | | Curriculum Option* |

Quarter 5

| | | |
|--------|-------|--------------------|
| MN0810 | (0-8) | Thesis Research |
| MN0810 | (0-8) | Thesis Research |
| MN4999 | | Curriculum Option* |
| MN4999 | | Curriculum Option* |

Quarter 6

| | | |
|--------|-------|----------------------|
| MN4999 | | Curriculum Option* |
| MN0810 | (0-8) | Thesis Research |
| MN4105 | (4-0) | Strategic Management |
| MN4999 | | Curriculum Option* |

*Student must consult with Academic Associate to select additional courses that meet student and sponsor needs.

SYSTEMS MANAGEMENT CURRICULUM 818

These programs are designed to provide the officers with fundamental interdisciplinary techniques of quantitative problem-solving methods, behavioral and management science, economic analysis and financial management and to enable the officers to evaluate the written research, study and analysis product of others throughout their careers. The curriculum will further provide the officers with the specific functional skills required to effectively manage.

These curricula are interdisciplinary programs which integrate mathematics, accounting, economics, behavioral science, management theory, operations/systems analysis and a subspecialty concentration area into an understanding of the process by which the defense mission is accomplished. Specialty concentration areas are selected by the student by their choice of course options.

International students are free to choose any of the specific management curricula

available, most choose the more general Systems Management International Curriculum . The 818 curriculum allows students to design a program of course work specific to management effectiveness in the host country's military system. The student may elect to specialize in the relevant portion of a functional area such as financial, logistics, human resources and organization, or manpower and personnel analysis. Or, the student may choose to follow a general management program which would include an overall balance of courses from many functional areas.

REQUIREMENT FOR ENTRY

A baccalaureate degree with above-average grades is required. Completion of at least two semesters of college algebra or trigonometry is considered to be the minimum mathematical preparation. An APC of 345 is required for entry; international students require a minimum TOEFL score of 540 (500-539 with supplemental language training).

International officers start the curriculum with widely varied academic backgrounds. Each student's prior academic work and related military and civilian experience is evaluated for courses previously completed and applicable to the student's curriculum so that academic credits may be transferred. Validation or credit by examination is encouraged.

ENTRY DATES

The 818 curriculum for International officers is a six-quarter course of study with entry dates in January and July. If further information is needed, contact the Academic Associate for this curriculum or the Curricular Officer.

Curriculum 818

Academic Associate:

International Officers - Systems Management

Roger Evered, Professor
Code SM/Ev, Ingersoll Hall, Room 201
(408) 656-2646, DSN 878-2646

DEGREE

Requirements for the degree Master of Science in Management are met as a milestone en route to satisfying the Educational Skill Requirements of the curricular program.

TYPICAL COURSE OF STUDY

INTERNATIONAL OFFICERS (818)

Quarter 1

| | | |
|--------|-------|--------------------------------|
| MN2150 | (4-0) | Financial Accounting |
| MN2031 | (4-0) | Economic Decision Making |
| MA2300 | (5-0) | Mathematics for Management |
| IS0123 | (0-2) | Computer Skills Development |
| IT1500 | (3-0) | American Life and Institutions |

Quarter 2

| | | |
|--------|-------|-------------------------------------|
| MN3161 | (4-0) | Managerial Accounting |
| MN3140 | (4-0) | Microeconomic Theory |
| MN3105 | (4-0) | Organization and Management |
| OS3101 | (4-1) | Statistical Analysis for Management |

Quarter 3

| | | |
|--------|-------|------------------------------------|
| MN4999 | (4-0) | Curriculum Option* |
| MN4999 | (4-0) | Curriculum Option* |
| MN3333 | (4-0) | Managerial Communication Systems |
| OS3006 | (4-0) | Operations Research for Management |

Quarter 4

| | | |
|--------|-------|--------------------|
| MN4999 | (4-0) | Curriculum Option* |
| MN4145 | (4-0) | Policy Analysis |

| | | |
|--------|-------|--------------------------------|
| IS3183 | (4-0) | Management Information Systems |
| MN4999 | (4-0) | Curriculum Option* |

Quarter 5

| | | |
|--------|-------|--------------------|
| MN0810 | (0-8) | Thesis Research |
| MN4999 | (4-0) | Curriculum Option* |
| MN4999 | (4-0) | Curriculum Option* |
| MN4999 | (4-0) | Curriculum Option* |

Quarter 6

| | | |
|--------|-------|----------------------|
| MN0810 | (0-8) | Thesis Research |
| MN0810 | (0-8) | Thesis Research |
| MN4105 | (4-0) | Strategic Management |
| MN4999 | (4-0) | Curriculum Option* |

*Student must consult with academic associate to select additional courses that meet student and sponsor needs.

SYSTEMS INVENTORY MANAGEMENT CURRICULUM 819

This curriculum emphasizes the management of Navy owned inventories at all levels. Curriculum 819 students take additional courses in general inventory model development and the specific details of the Navy's inventory models, spanning the three levels of whole-sale, intermediate and retail customer support. Officers are responsible for developing procedures for establishing, maintaining and controlling inventories of material, distributing that material to the Navy customer, and developing the budgets for financing these inventories.

The Systems Inventory Management curriculum is interdisciplinary, integrating mathematics, accounting, economics, management theory, operations analysis and the specialty concentration into an understanding of the process by which the defense mission is accomplished.

REQUIREMENTS FOR ENTRY

A baccalaureate degree with above-average grades is required. Completion of at least two semesters of college algebra or trigonometry is considered to be the minimum mathematical preparation. An APC of 345 is required for entry; international students require a minimum TOEFL of 540 (500-539 with supplemental language training).

Officers from the Navy's Supply Corps start the curriculum with widely varied academic backgrounds. Each student's prior academic work and related military experience is evaluated for courses previously completed and applicable to the student's curriculum so that academic credits may be transferred. Validation or credit by examination is encouraged.

SYSTEMS INVENTORY MANAGEMENT SUBSPECIALTY

Completion of this curriculum qualifies a naval officer as a Systems Inventory Management Subspecialist with a subspecialty code of 1302P. The Curriculum Sponsor is Naval Supply Systems Command Headquarters.

Typical Jobs in this Subspecialty:

Inventory Control Methods and Requirements: Fleet and industrial Support Center
 Stock Control: Naval Air Station
 Director of Program Support Office, Ships Parts Control Center: Mechanicsburg, PA
 Director of Nuclear Reactor Stock Control Requirements, Ships Parts Control Center: Mechanicsburg, PA
 Division Director, Defense Electronic Supply Center, Dayton, OH
 Stock Control Requirements Planning, Naval Submarine Support Facility, New London, CN
 Director of Logistics Strategic Planning, Bureau of Medicine, Washington D.C.

Director, Supply Systems Design Department, Ships Part Control Center:
Mechanicsburg, PA
Chief Navy Systems Readiness group, Defense General Supply Center, Richmond, VA

ENTRY DATES

Systems Inventory Management is a six-quarter course of study with an entry date in July. If further information is needed, contact the Academic Associate for this curriculum or the Curricular Officer.

Curriculum 819

Academic Associate:

Alan W. McMasters, Associate Professor
Code SM/Mg, Ingersoll Hall
Room 209
(408)656-2678, DSN 878-2678.

DEGREE

Requirements for the degree Master of Science in Management are met as a milestone en route to satisfying the Educational Skill Requirements of the curricular program.

***TYPICAL COURSE OF STUDY**

Quarter 1

| | | |
|--------|-------|---------------------------------|
| MN2150 | (4-0) | Financial Accounting |
| MN2031 | (4-0) | Economic Decision Making |
| MN3333 | (4-0) | Managerial Communication Skills |
| MA2300 | (5-0) | Mathematics for Management |
| IS0123 | (0-2) | Computer Skills Development |

Quarter 2

| | | |
|--------|-------|-----------------------------------|
| MN3161 | (4-0) | Managerial Accounting |
| MN3140 | (4-0) | Microeconomic Theory |
| OS3105 | (4-0) | Statistics for Systems Management |
| MN3172 | (4-0) | Public Policy and Budgeting |

Quarter 3

| | | |
|--------|-------|------------------------------------|
| IS3183 | (4-0) | Management Information Systems |
| MN3372 | (4-0) | Material Logistics |
| MN3105 | (4-0) | Organization and Management |
| OS3006 | (4-0) | Operations Research for Management |

Quarter 4

| | | |
|--------|-------|--|
| OA3501 | (4-0) | Inventory 1 |
| MN4145 | (4-0) | Policy Analysis |
| MN4310 | (4-0) | Logistics Engineering |
| MN4312 | (4-0) | Simulation Modeling for Managerial Decision Making |

Quarter 5

| | | |
|--------|--------|---------------------------------------|
| MN0810 | (0-16) | Thesis Research |
| NS3252 | (4-0) | Joint and Maritime Strategic Planning |
| OA4501 | (4-0) | Seminar in Supply Systems |

Quarter 6

| | | |
|--------|-------|--|
| MN0810 | (0-8) | Thesis Research |
| MN4105 | (4-0) | Strategic Management |
| MN3154 | (4-0) | Financial Management in the Armed Forces |
| MN3371 | (4-0) | Contracts Management and Administration |

*If a course is validated, an alternate course may be selected from the following list:
MN3301 (4-0) System Acquisition and Project Management

| | |
|--------|---|
| MN3374 | (4-0) Production Management |
| MN3375 | (4-0) Materials Handling Systems Design |
| MN3111 | (4-0) Personnel Management Processes |

RESOURCE PLANNING AND MANAGEMENT FOR INTERNATIONAL DEFENSE CURRICULUM 820

The Resource Planning and Management for International Defense Curriculum is an interdisciplinary program, designed exclusively for officers and civilian employees in defense agencies of other countries. The program focuses on economic analysis, the management of financial, material, and human resources, domestic and international political institutions, civil-military relations, and the role of international law. The curriculum is made up of a combination of existing courses within the Systems Management and National Security Affairs departments and courses especially designed for this program. In the majority of courses, international students will study and learn with U.S. students from several other management and national security affairs curricula.

REQUIREMENT FOR ENTRY

A baccalaureate degree with above-average grades, fluency in written and verbal English, and a minimum score of 540 on the *Test of English as a Foreign Language* (TOEFL). Supplemental English language training is required for students who score 500-539.

Officers and civilian employees in defense agencies of allied countries enter the curriculum with widely varied academic and military backgrounds and are evaluated on an individual basis. Validation or credit by examination is encouraged.

ENTRY DATES

Resource Planning and Management for International Defense Curriculum 820 is a six-quarter (18 months) course of study with an entry date of January. If further information is needed, contact the Academic Associate for the curriculum or the Curricular Officer.

Curriculum 820

Academic Associate:

Roger Evered, Professor
Code SM/Ev, Ingersoll Hall, Room 201
(408) 656-2646, DSN 878-2646

DEGREE

Master of Science in International Resource Planning and Management

Quarter 1

| | | |
|--------|-------|---|
| MN2150 | (4-0) | Financial Accounting |
| NS3023 | (4-0) | Intro to Comparative Politics |
| MN2039 | (4-0) | Basic Quantitative Methods in Econ Analysis |
| IT1500 | (3-0) | American Life and Institution |
| IS0123 | (0-2) | Computer Skills Development |

Quarter 2

| | | |
|--------|-------|-----------------------------------|
| MN3161 | (4-0) | Management Accounting |
| NS3030 | (4-0) | American National Security Policy |
| NS3140 | (4-0) | Microeconomic Theory |
| MN3172 | (4-0) | Public Policy and Budgeting |

Quarter 3

| | | |
|--------|-------|---|
| MN3333 | (4-0) | Managerial Communication |
| NS3036 | (4-0) | Military & Politics in the Developing World |
| NS3041 | (4-0) | Comparative Economic Systems |
| MN3105 | (4-0) | Organization and Management |

Quarter 4

| | | |
|--------|-------|-------------------------------------|
| IS3183 | (4-0) | Management Information Systems |
| NS3900 | (4-0) | International Law and Organizations |
| MN4145 | (4-0) | Policy Analysis |
| MN3111 | (4-0) | Personnel Management Processes |

Quarter 5

| | | |
|--------|-------|---|
| MN0810 | (0-8) | Thesis |
| NS3037 | (4-0) | Role of Congress in U.S. National Security Policy |
| MN0810 | (0-8) | Thesis |
| MN4999 | (4-0) | Elective |

Quarter 6

| | | |
|--------|-------|--|
| MN0810 | (0-8) | Thesis |
| MN0810 | (0-8) | Thesis |
| MN4105 | (4-0) | Strategic Management |
| NS4240 | (4-0) | Seminar on Regional Security Planning Problems |

MATERIAL LOGISTICS SUPPORT MANAGEMENT CURRICULUM 827

The Material Logistics Support Management curriculum emphasizes all of the aspects for providing integrated logistics support of weapons systems. Besides study in mathematics, accounting, economics, behavioral science, management theory and operations analysis, the curriculum delves into production management, inventory management, integrated logistic support, procurement and contract administration, systems acquisition and project management. Skills resulting from the curriculum will prepare those responsible for managing the various segments of a military system's life cycle from initial planning for support to fielding the system, through sustaining operations to phaseout.

REQUIREMENTS FOR ENTRY

A baccalaureate degree with above-average grades is required. Completion of at least two semesters of college algebra or trigonometry is considered to be the minimum mathematical preparation. An APC of 345 is required for entry.

Officers from the U.S. Services, as well as others, start the curriculum with widely varied academic backgrounds. Each student's prior academic work and related military experience is evaluated for courses previously completed and applicable to the student's curriculum so that academic credits may be transferred. Validation or credit by examination is encouraged.

MATERIAL LOGISTICS SUPPORT MANAGEMENT SUBSPECIALIST

Completion of this curriculum qualifies an officer as a Material Logistics Support Management Subspecialist, subspecialty code XX32P. The Curriculum sponsor is Naval Air Systems Command Headquarters.

Typical Jobs in this Subspecialty:

Aircraft Intermediate Maintenance: Naval Air Stations and Aircraft Carriers
Project Management Staff: Naval Air Systems Command, Washington, DC
Integrated Logistics Support
Coordinator for Operational Support: Naval Air Systems Command, Washington, DC
Director of Receiving: Fleet & Industrial Support Centers (FISC)
Director of Storage: FISC & DLA Depots

ENTRY DATES

Material Logistics Support Management is a six-quarter course of study with entry dates in January and July. If further information is needed, contact the Academic Associate for this curriculum or the Curricular Officer.

Curriculum 827

Academic Associate:

Alan W. McMasters, Professor
Code SM/Mg, Ingersoll Hall
Room 209
(408) 656-2678, DSN 878-2678.

DEGREE

Requirements for the degree Master of Science in Management are met as a milestone en route to satisfying the Educational Skill Requirements of the curricular program.

TYPICAL COURSE OF STUDY

Quarter 1

| | | |
|--------|-------|---------------------------------|
| MN2150 | (4-0) | Financial Accounting |
| MN2031 | (4-0) | Economic Decision Making |
| MN3333 | (4-0) | Managerial Communication Skills |
| MA2300 | (5-0) | Mathematics for Management |
| IS0123 | (0-2) | Computer Skills Development |

Quarter 2

| | | |
|---------|-------|-------------------------------------|
| MN3161 | (4-0) | Managerial Accounting |
| MN3140 | (4-0) | Microeconomic Theory |
| OS3101* | (4-1) | Statistical Analysis for Management |
| MN3172 | (4-0) | Public Policy and Budgeting |
| MN3221 | (2-0) | Principles of Project Management I |

Quarter 3

| | | |
|--------|-------|-------------------------------------|
| MN3372 | (4-0) | Material Logistics |
| MN3222 | (3-2) | Principles of Project Management II |
| OS3006 | (4-0) | Operations Research for Management |
| MN3105 | (4-0) | Organization and Management |

Quarter 4

| | | |
|--------|-------|---|
| MN3371 | (4-0) | Contracts Management and Administration |
| MN4145 | (4-0) | Policy Analysis |
| MN4310 | (4-0) | Logistics Engineering |
| IS3183 | (4-0) | Management Information Systems |

Quarter 5

| | | |
|--------|--------|-----------------------|
| MN0810 | (0-16) | Thesis Research |
| MN3374 | (4-0) | Production Management |
| MN4999 | (4-0) | Curriculum Option** |

Quarter 6

| | | |
|--------|-------|--|
| MN0810 | (0-8) | Thesis Research |
| MN4105 | (4-0) | Strategic Management |
| MN3154 | (4-0) | Financial Management in the Armed Forces |
| NS3252 | (4-0) | Joint and Maritime Strategic Planning |

*OS3105 may be taken instead of OS3101. This substitution will allow certain curriculum option courses below to be taken from the Operations Research Department. The decision to take OS3105 must be made early in the first quarter.

**OA3401, 3501, 4302 and 4303 may only be taken after OS3104 is taken.

*One additional course must be selected from the following curriculum options:

| | |
|--------|---|
| MN3111 | Personnel Management Processes |
| MN3373 | Domestic Transportation Management |
| MN3375 | Materials Handling Systems Design |
| MN3377 | Inventory Mgmt (required for Supply Corps Officers) |

| | |
|--------|--|
| MN3401 | Human Factors in Systems Design 1 |
| OA3501 | Inventory 1 |
| OA4302 | Reliability and Weapon Systems Effectiveness Measurement |
| OA4303 | Sample Inspection and Quality Assurance |

FINANCIAL MANAGEMENT

CURRICULUM 837

The objective of the Financial Management Curriculum is to prepare officers for business and financial positions within the Navy. Financial Managers assist the Navy's decision-making processes at all levels by providing accurate, timely and relevant information. They are concerned with the optimal allocation of human, physical and financial resources to achieve the Navy's goals and objectives while assuring efficient and effective expenditure of public funds.

Graduate courses cover topics such as financial reporting standards, cost standards, cost analysis, budgeting, internal control, financial auditing, operational auditing, management planning and control systems, quantitative techniques used in planning and control, and the Planning Program and Budgeting System used within the Department of Defense.

Graduates of the Financial Management Curriculum will be prepared for assignment to positions in budgeting, accounting, business and financial management, and internal control and auditing.

REQUIREMENTS FOR ENTRY

A baccalaureate degree with above-average grades is required. Completion of at least two semesters of college algebra or trigonometry is considered to be the minimum mathematical preparation. An APC of 345 is required for entry; for international students, a minimum TOEFL of 540 (500-539 with supplemental language training) is required.

Officers from the U.S. Services, as well as all others, start the curriculum with widely varied academic backgrounds. Each student's prior academic work and related military experience is evaluated for courses previously completed and applicable to the student's curriculum so that academic credits may be transferred. Validation or credit by examination is encouraged.

FINANCIAL MANAGEMENT SUBSPECIALTY

Completion of this curriculum qualifies an officer as a Financial Management Subspecialist, subspecialty code XX31P. The Curriculum Sponsor is N-82, Fiscal Management Division.

Typical Jobs in this Subspecialty:

Comptroller: Naval Air Stations
 Budgeting Commander: Naval Medical Command, Washington, DC
 Accounting Commander: Naval Medical Command, Washington, DC
 Budget Officer Commander: Naval Air Forces Atlantic, Norfolk, VA
 Comptroller: Naval Supply Depots/Naval Supply Centers
 Fiscal Officer: Naval Supply Depots/Naval Supply Centers
 Public Works Officer: Weapons Stations, CONUS
 Cost Analysis Office of Secretary of the Navy: Washington, DC
 Special Assistants Program: Planning Office (NAVY), Fiscal Management Division (N-82)

ENTRY DATES

Financial Management is a six-quarter course of study with entry dates in January and July. If further information is needed, contact the Academic Associate for this curriculum or the Curricular Officer.

Curriculum 837

Academic Associate:

Douglas Moses, Associate Professor

Code SM/Mo, Ingersoll Hall

Room 303

(408) 656-3218, DSN 878-3218.

DEGREE

Requirements for the degree Master of Science in Management are met en route to satisfying the Educational Skill Requirements of the curricular program.

TYPICAL COURSE OF STUDY

Quarter 1

| | | |
|--------|-------|---------------------------------|
| MN2150 | (4-0) | Financial Accounting |
| MN2031 | (4-0) | Economic Decision Making |
| MN3333 | (4-0) | Managerial Communication Skills |
| MA2300 | (5-0) | Mathematics for Management |
| IS0123 | (0-2) | Computer Skills Development |

Quarter 2

| | | |
|--------|-------|-------------------------------------|
| MN3161 | (4-0) | Management Accounting |
| MN3140 | (4-0) | Microeconomic Theory |
| MN3105 | (4-0) | Organization and Management |
| OS3101 | (4-1) | Statistical Analysis for Management |

Quarter 3

| | | |
|--------|-------|------------------------------------|
| MN4161 | (4-0) | Management Control Systems |
| MN3172 | (4-0) | Public Policy and Budgeting |
| MN4162 | (4-0) | Cost Management |
| OS3006 | (4-0) | Operations Research for Management |

Quarter 4

| | | |
|--------|-------|---|
| MN3154 | (4-0) | Financial Management in the Armed Forces |
| MN4145 | (4-0) | Policy Analysis |
| MN4151 | (2-0) | Internal Control and Auditing |
| IS3183 | (4-0) | Management Information Systems |
| MN3805 | (2-0) | Total Quality Leadership and the Military |

Quarter 5

| | | |
|--------|-------|---------------------------------------|
| MN0810 | (0-8) | Thesis Research |
| MN0810 | (0-8) | Thesis Research |
| MN4XXX | (4-0) | Curriculum Option* |
| NS3252 | (4-0) | Joint and Maritime Strategic Planning |

Quarter 6

| | | |
|--------|-------|--|
| MN3301 | (4-0) | Systems Acquisition and Project Management |
| MN0810 | (0-8) | Thesis Research |
| MN4105 | (4-0) | Strategic Management |
| MN4XXX | (4-0) | Curriculum Option* |

*The student will select two courses from the following curriculum options:

Winter and Summer Quarters:

MN4122 Planning & Control: Measurement & Evaluation

MN4152 Corporate Financial Management

MN4159 Financial Reporting & Analysis

MN4305 Defense Technology Management

Fall and Spring Quarters:

| | |
|--------|--|
| MN4153 | Seminar in Financial Management |
| MN4163 | Analytical Techniques for Financial Control & Planning |
| MN4302 | Defense Resource Policy & Managment |
| OA4702 | Cost Estimation |

MANPOWER, PERSONNEL AND TRAINING ANALYSIS CURRICULUM 847

Officers enrolled in the Manpower, Personnel and Training Analysis (MPTA) curriculum at the Naval Postgraduate School undertake the challenge of an academic program designed to fill the leadership roles in military manpower management. The XX33P Subspecialty has primary responsibility for developing and analyzing policies to ensure that the Navy is recruiting, training, utilizing and retaining personnel in the most efficient and effective ways possible. MPTA is an extremely analytical curriculum intended to develop skills necessary to perform and evaluate manpower analyses. As such, the curriculum emphasizes mathematical, statistical and other quantitative methods. Successful completion of the curriculum yields an officer skilled in conducting manpower policy analysis.

The areas covered in the MPTA curriculum include an understanding of MPT policy development, compensation systems, enlistment supply and retention models, manpower training models, manpower requirements determination processes, career mix, enlistment incentives, reenlistment incentives, training effectiveness measures and hardware/manpower trade-offs. Students gain familiarity with current models and methods of MPT analysis as well as military MPT organizations and issues.

REQUIREMENTS FOR ENTRY

A baccalaureate degree with above-average grades is required. Completion of at least two semesters of college algebra or trigonometry is considered to be the minimum mathematical preparation. Additional preparation in calculus and statistics is considered very advisable. An APC of 345 is required for entry; for international students, a minimum TOEFL of 540 (500-539 with supplemental language training) is required.

Prospective students electing MPTA as a subspecialty must be adequately prepared by their undergraduate curriculum and comfortably oriented to a quantitatively rigorous graduate curriculum.

Officers from the U.S. Services, as well as all others, start the curriculum with widely varied academic backgrounds. Validation by examination is encouraged.

MANPOWER, PERSONNEL AND TRAINING ANALYSIS SUBSPECIALTY

Completion of this curriculum qualifies an officer as a Manpower, Personnel and Training Analyst Subspecialist, subspecialty code XX33P. The Curriculum Sponsor is PERS-2, Assistant Chief of Naval Personnel Policy and Career Progression.

Typical Jobs in this Subspecialty:

Head, Enlisted Plans Branch (PERS-222)

Deputy Chief of Naval Operations

Chief of Naval Personnel

Assistant Chief of Naval Personnel for Military Personnel Policy and Career Progression (PERS-2)

Manpower & Training Analyst (N801D)

Chief of Naval Operation

Deputy Chief of Naval Operation (Resources, Warfare Requirements, & Assessment) (N8)

Military Personnel, Navy, Program Analyst (N120C5)

Deputy Chief of Naval Operations (Manpower & Personnel) (N1)

Director, Total Force Programming/Manpower (N12)

Commanding Officer, Navy Manpower Analysis Center, Norfolk, Virginia
Head, Joint Manpower Management Branch
Joint Chiefs of Staff
Director for Manpower & Personnel (J-1)
Head, Personnel/Manpower Management
Naval Hospital, Pensacola, FL

ENTRY DATES

Manpower, Personnel and Training Analysis is a seven-quarter course of study with an entry date in July. If further information is needed, contact the Academic Associate for this curriculum or the Curricular Officer.

Curriculum 847

Academic Associate:

Stephen Mehay, Professor
Code SM/Mp, Ingersoll Hall, Room 343
(408) 656-2643, DSN 878-2643

DEGREE

Requirements for the degree Master of Science in Management are met en route to satisfying the Educational Skill Requirements of the curricular program.

TYPICAL COURSE OF STUDY

Quarter 1

| | | |
|--------|-------|-----------------------------|
| MN2150 | (4-0) | Financial Accounting |
| MN2031 | (4-0) | Economic Decision Making |
| MN2111 | (0-2) | Seminar in MPTA Issues |
| MA2300 | (5-0) | Mathematics for Management |
| IS0123 | (0-2) | Computer Skills Development |

Quarter 2

| | | |
|--------|-------|-------------------------------------|
| MN3161 | (4-0) | Managerial Accounting |
| MN3140 | (4-0) | Microeconomic Theory |
| OS3101 | (4-2) | Statistical Analysis for Management |
| MN3902 | (0-2) | Computer Skills Enhancement |

Quarter 3

| | | |
|--------|-------|---------------------------------------|
| MN3760 | (4-0) | Manpower Economics |
| MN3333 | (4-0) | Managerial Communication Skills |
| MN4110 | (4-1) | Multivariate Manpower Data Analysis 1 |
| MN3105 | (4-0) | Organization and Management |
| MN2112 | (0-2) | Seminar in MPTA Issues |

Quarter 4

| | | |
|--------|-------|---------------------------------------|
| IS3183 | (4-0) | Management Information Systems |
| MN3111 | (4-0) | Personnel Processes |
| MN4111 | (4-1) | Multivariate Manpower Data Analysis 2 |
| OS3006 | (4-0) | Operations Research for Management |

Quarter 5

| | | |
|--------|-------|-------------------------------------|
| MN4115 | (4-0) | Training Foundations and Management |
| MN4761 | (4-0) | Applied Manpower Analysis |
| OS4701 | (4-0) | Manpower and Personnel Models |
| MNXXXX | (4-0) | Manpower Elective* |

Quarter 6

| | | |
|--------|-------|------------------------------------|
| MN0810 | (0-8) | Thesis |
| MN0810 | (0-8) | Thesis |
| MN3172 | (4-0) | Public Policy and Budgeting |
| MN4106 | (4-0) | Manpower/Personnel Policy Analysis |

Quarter 7

| | | |
|--------|-------|-----------------------------------|
| MN0810 | (0-8) | Thesis |
| MN0810 | (0-8) | Thesis |
| MN4105 | (4-0) | Strategic Management |
| NS3252 | (4-0) | Joint/Maritime Strategic Planning |

*Students will select from the following courses:
 MN4112 Personnel Testing & Selection (4-0)
 MN4114 Social-Psychological Context of Military Service

EDUCATIONAL SKILL REQUIREMENTS INFORMATION TECHNOLOGY MANAGEMENT CURRICULUM (370)

With the new information Age has come the Age of Information Warfare and a Military Technical Revolution. This revolution will require new war fighting concepts, doctrines, C41 systems and precision guided weapons. The enabling capabilities of the military technical revolution are information dominance, command and control, simulation and training, and agility. Smart weapons, major platforms, and exotic weapons are the executing capabilities, while doctrine and organization form the integrating framework. Information Technology is the foundation for the enabling and executing capabilities. Information Technology Management is at the very core of the integrating framework. The military technical revolution's goal of battle space control requires a deep understanding of and an action orientation toward information technology and information technology management.

The operational and tactical expression of the military technical revolution is Space and Electronic Warfare (C2 Warfare). The disciplines of this new warfare arena [OPDEC, Counter-Surveillance, Counter-C41, Electronic Combat, OPSEC, Surveillance, C41, and Signals Management] are possible because of information technology. The Space and Electronic Warfare Commander's four functions [Force Sensor Management, Electronic Combat Management, Battlespace Management, and Information Management] require a deep understanding of Information Technology Management as well as the foundational technology. The Space and Electronic Warfare Commander's information management functional expertise is exactly the expertise of the graduates of the information technology management curriculum.

In addition to an increasing role afloat, the graduates of the information technology management have the expertise to efficiently and effectively design, implement, operate and manage systems associated with the classic functions of ADP and ADP management as well as telecommunications and telecommunications management. These classic functions provide the deep combat support needed by a warfighter engaged in sustained action. However, in the Age of Information War these historical "behind the lines" functions are reachable by exotic information weapons. The functions supported by the expertise of the information technology management graduate extend throughout the "spear of war" from the "pointy end" to the "support tail". Information Technology Management is now a critical success factor in information war, and the information technology management graduate can be a leader in the military technical revolution.

Information Technology Management involves (a) the engineering of an information system (C41 system), (b) the leading and managing of the creation and operation of the system, and (c) the synthesis of problem solutions to problems arising in engineering and management of information systems. The graduate of the curriculum is an Information Systems Engineering and Management Professional. This professional has the knowledge, skills and competencies necessary to efficiently and effectively create, operate and manage information (C41) systems ashore and afloat. This is demonstrated in classroom activities, team projects, and in the independent solution of a significant DoN/DoD information technology management problem. Each of the three areas of information technology management will be described below.

INFORMATION SYSTEMS ENGINEERING ASHORE AND A FLOAT

The information systems engineering and management professional can system engineer an information system to support decision making ashore and afloat. The systems engineering capability is based on an understanding of computer and communications systems technology, database and database management system technology, decision support and decision aid technology, software engineering, systems analysis and design, systems engineering, information engineering, INFOSEC, and DoD/DoN standards and practices compliant with Joint and Maritime Strategic Planning and DoD/DoN/Joint architectures and interoperability standards.

MANAGING INFORMATION SYSTEMS, CENTERS AND RESOURCES ASHORE AND AFLOAT

The Information System Engineering and Management Professional can lead and manage the acquisition and operation of computer centers, communication stations, command centers, information centers, and systems on an end to end basis. This capability is based on an understanding of facilities planning, production planning and control, manpower and personal planning and leading, budgeting and control, strategic management, organization structure and processes, organizational change, acquisition management from within DoN to and including Congress.

SYNTHESIS AND PROBLEM SOLUTION FOR ENGINEERING AND MANAGEMENT DECISION MAKING

The Information System Engineering and Management Professional can analyze, model, and synthesize solutions to engineering and management problems. This capability is based on an understanding of decision theory, economic analysis, operations analysis, cost and operational effectiveness analysis, systems analysis, risk analysis, requirements determination, functional analysis and allocation, and technological forecasting. The completion of an independent project solving a DoD/DoN information technology management problem demonstrates this capability.

EDUCATIONAL SKILL REQUIREMENTS MATERIAL MOVEMENT CURRICULUM (813)

- 1. MANAGEMENT FUNDAMENTALS - QUANTITATIVE ANALYSIS:** The graduate will have the skills to apply mathematical, statistical, accounting, economic and other state-of-the-art-quantitative techniques and concepts to the solving of day-to-day military management problems as well as the capability to use these skills as a participant in the long range strategic planning efforts of the Navy and DoD.
- 2. MANAGEMENT FUNDAMENTALS - ORGANIZATION AND MANAGEMENT:** The graduate will have a thorough knowledge of basic management theory and practices, embracing leadership, communication, organizational design, staffing, directing, planning and controlling of military organizations.
- 3. CONTRACT AND PROJECTS MANAGEMENT:** The graduate will have detailed knowledge about the DoD process for contracting for material and services. The graduate will also have an understanding of the processes to be followed for a major weapon system's procurement and its support.
- 4. BUDGETING AND FINANCIAL CONTROLS:** The graduate will have an understanding of the financial management practices of DoD, will be able to conduct cost/benefit analyses, and participate in the budgetary planning for transportation services.
- 5. TRANSPORTATION MANAGEMENT:** The graduate will have an in-depth understanding of domestic and international private sector transportation systems including the various modes, type of carriers within each mode, and the regulations affecting material movement by each type of carrier. The graduate will also understand the impact that these private sector systems have on the planning for defense transportation by TRANSCOM and the individual services.
- 6. TRANSPORTATION RESOURCE MANAGEMENT:** The graduate will have the ability to manage transportation resources to move material from the Navy and DoD supply depots to the fleet customers.
- 7. JOINT AND MARITIME STRATEGIC PLANNING:** The graduate will have an understanding of the development and execution of military strategy, the effects of technical developments on warfare, the processes for formulating U.S. policy, the roles of military forces, joint planning and current issues in the defense organization.
- 8. THESIS:** The graduate will demonstrate the ability to conduct independent research and analysis, and proficiency in presenting the results in writing by means of a thesis appropriate to this curriculum.

EDUCATIONAL SKILL REQUIREMENTS TRANSPORTATION MANAGEMENT CURRICULUM (814)

- 1. MANAGEMENT FUNDAMENTALS - QUANTITATIVE ANALYSIS:** The graduate will have the skills to apply mathematical, statistical, accounting, economic and other state-of-the-art quantitative techniques and concepts to the solving of day-to-day military management problems as well as the capability to use these skills as a participant in the long range strategic planning efforts of the Navy and DoD.
- 2. MANAGEMENT FUNDAMENTALS - ORGANIZATION AND MANAGEMENT:** The graduate will have a thorough knowledge of basic management theory and practices, embracing leadership, communication, organizational design, staffing, directing, planning and controlling of military organizations.
- 3. MANAGEMENT OF PERSONNEL:** The graduate will have the ability to apply current innovations in personnel management to the management of civilian and military personnel involved in DoD transportation activities.
- 4. CONTRACTS AND PROJECTS MANAGEMENT:** The graduate will have detailed knowledge about the DoD processes for contracting for transportation and other services. An in-depth knowledge of the DoD project management processes will allow the graduate to participate in MCS/NAVSEA projects for procurement of new MSC ships.
- 5. BUDGETING AND FINANCIAL CONTROLS:** The graduate will have an understanding of the financial management practices of DoD, will be able to conduct cost/benefit analyses, and participate in the budgetary planning for transportation services.
- 6. TRANSPORTATION MANAGEMENT:** The graduate will have an in-depth understanding of domestic and international private sector transportation systems including the various modes, types of carriers within each mode, and the regulations affecting material movement by each type of carrier. The graduate will also understand the impact that these private sector systems have on the planning for defense transportation by TRANSCOM and the individual services.
- 7. TRANSPORTATION SYSTEM DESIGN TO SUPPORT STRATEGIC SEALIFT AND MOBILIZATION:** The graduate will have a detailed understanding of the plans and processes of the Navy and DoD for providing support of strategic sealift and mobilization. The graduate will be able to determine, obtain, and schedule the transportation and materials handling resources to support strategic sealift operations and to move material to the operating fleet and troop units in the event of a mobilization.
- 8. JOINT AND MARITIME STRATEGIC PLANNING:** The graduate will have an understanding of the development and execution of military strategy, the effects of technical developments on warfare, the processes for formulating U.S. policy, the roles of military forces, joint planning and current issues in the defense organization.
- 9. THESIS:** The graduate will demonstrate the ability to conduct independent research and analysis, and proficiency in presenting the results in writing by means of a thesis appropriate to this curriculum.

EDUCATIONAL SKILL REQUIREMENTS ACQUISITION & CONTRACT MANAGEMENT CURRICULUM (815)

- 1. MANAGEMENT FUNDAMENTALS:** The graduate will understand the theory of and have an ability to apply accounting, economic, mathematical, statistical, managerial and other state-of-the-art management techniques and concepts to problem solving and decision-making responsibilities as military managers.
- 2. ADVANCED MANAGEMENT CONCEPTS:** The graduate will have the ability to apply advanced management and operations research techniques to defense problems. This includes policy formulation and execution, strategic planning, Defense resource Federal fiscal policy, computer-based information and decision support systems, and complex managerial situations requiring comprehensive integrated decision-making.
- 3. ACQUISITION AND CONTRACTING PRINCIPLES:** The graduate will have an understanding of and will be able to apply the principles and fundamentals of acquisition and contracting within the Federal Government including knowledge of the acquisition laws and regulations, particularly the Federal Acquisition Regulation (FAR) and the DoD FAR Supplement (DFARS); the unique legal principles applied in Government contract law and the Uniform Commercial Code; and the application of sound business principles and practices to Defense contracting problems. Further, the graduate will be able to apply innovative and creative approaches not only to resolve difficult acquisition and contracting issues but to significantly influence the legal and regulatory structure within which acquisition decision-making occurs.
- 4. ACQUISITION AND CONTRACTING POLICY:** The graduate will have an ability to formulate and execute acquisition policies, strategies, plans and procedures; a knowledge of the legislative process and an ability to research and analyze acquisition legislation; and a knowledge of the government organization for acquisition, including Congress, the General Accounting Office, the Office of Federal Procurement Policy, the Federal and Military contracting offices, the Boards of Contract Appeals, and the court system.
- 5. CONTRACTING PROCESS:** The graduate will understand the theory of and have the ability to manage the field contracting, system acquisition and contract administration processes. This involves a knowledge of the defense system life cycle processes, including requirements determination, funding, contracting, ownership, and disposal; an ability to evaluate military requirements, specifications, and bids and proposals; an ability to utilize the sealed bid, competitive proposals and small purchase contracting methodologies; a comprehensive knowledge of all contract types and their application in defense acquisition; an ability to conduct cost and price analyses; and an ability to negotiate various contracting actions including new procurement, contract changes and modifications, claims, equitable adjustment settlements, and noncompliance issues.
- 6. BUSINESS THEORY AND PRACTICES:** The graduate will have an understanding of the business philosophy, concepts, practices and methodologies of the defense/commercial industrial base and the ability to apply these to the federal government acquisition environment.

- 7. FEDERAL AND DEFENSE BUDGETING:** The graduate will have an ability to apply economic and accounting principles, including monetary and fiscal theories, to defense acquisition and contracting issues.
- 8. PROGRAM MANAGEMENT:** The graduate will have an understanding of the basic principles and fundamentals of Program Management, with particular emphasis on the Procuring Contractor Officer's and Administrative Contracting Officer's roles and relationships with the Program Manager.
- 9. ACQUISITION WORKFORCE:** The graduate will satisfy all requirements of the Defense Acquisition Workforce Improvement Act (DAWIA) and mandatory contracting courses required by the Defense Acquisition University (DAU) at levels I, II, and III.
- 10. ETHICS AND STANDARDS OF CONDUCT:** The graduate will have an ability to manage and provide leadership in the ethical considerations of military acquisition, including the provisions of procurement integrity, and to appropriately apply Defense acquisition standards of conduct.
- 11. JOINT AND MARITIME STRATEGIC PLANNING:** American and world military history and joint and maritime planning including the origins and evolution of national and allied strategy; current American and allied military strategies which address the entire spectrum of conflict; the U.S. maritime component of national military strategy; the organizational structure of the U.S. defense establishment; the role of the commanders of unified and specified commands in strategic planning; the process of strategic planning; joint and service doctrine, and the roles and missions of each in meeting national strategy.
- 12. THESIS:** The graduate will demonstrate the ability to conduct independent research and analysis, and proficiency in presenting the results in writing by means of a thesis appropriate to this curriculum.

EDUCATIONAL SKILL REQUIREMENTS SYSTEMS ACQUISITION MANAGEMENT CURRICULUM (816)

- 1. MANAGEMENT FUNDAMENTALS:** The graduate will understand the theory of and have an ability to apply accounting, economic, mathematical, statistical, managerial and other state-of-the-art management techniques and concepts to problem solving and decision-making responsibilities as military managers.
- 2. ADVANCED MANAGEMENT CONCEPTS:** The graduate will have the ability to apply advanced management and operations research techniques to defense problems. This includes policy formulation and execution, strategic planning, defense resource allocation, cost benefit and cost effectiveness analysis, federal fiscal policy, computer-based information and decision support systems, and complex managerial situations requiring comprehensive integrated decision-making.
- 3. PROGRAM MANAGEMENT PRINCIPLES:** The graduate will have an understanding of and will be able to apply the principles, concepts, and techniques of program management to the acquisition of major defense weapon systems. This includes the principles of risk management and tradeoff decision analysis using cost, schedule and performance parameters over the entire life cycle of a project.
- 4. PROGRAM MANAGEMENT POLICIES:** The graduate will have an ability to formulate and execute defense acquisition policies, strategies, plans and procedures; an understanding of the policy-making roles of various federal agencies of the Executive, Legislative and Judicial branches of the government, particularly the Department of Defense (DoD), the General Accounting Office (GAO), congressional committees, the Office of Management and Budget (OMB); and an understanding of the strategies necessary to influence policy development and implementation.
- 5. SYSTEMS ACQUISITION PROCESS:** The graduate will understand the theory of and have an ability to manage the systems acquisition process. This involves the system life cycle process for requirements determination, research and development, funding and budgeting, procurement, systems engineering, test and evaluation, manufacturing and quality control, integrated interrelationship between reliability, maintainability and logistics support as an element of system effectiveness in defense system/equipment design; and embedded weapon system software, particularly related to current policies and standards, software metrics, risk management, inspections, testing, integration, and post-deployment software support.
- 6. CONTRACT MANAGEMENT:** The graduate will understand the role of the contracting process within the acquisition environment including financial, legal, statutory, technical and managerial constraints in the process.
- 7. BUSINESS THEORY AND PRACTICES:** The graduate will have an understanding of the business and operating philosophies, concepts, practices and methodologies of defense industry with regard to major weapon systems acquisition, particularly the application of sound business practices.

8. GOVERNMENT AND INDUSTRY BUDGETING AND FINANCIAL

MANAGEMENT: The graduate will have an understanding of and an ability to apply the principles of government and private organizational financing including corporate financial structures, cost and financial accounting, capital budgeting techniques, financial analysis, and defense financial management and budgeting processes to include the Government Planning, Programming and Budgeting System (PPBS).

9. ACQUISITION WORKFORCE: The graduate will satisfy all requirements of the Defense Acquisition Workforce Improvement Act (DAWIA) and mandatory Program Management courses required by the Defense Acquisition University (DAU) at levels I, II, and III.

10. ETHICS AND STANDARDS OF CONDUCT: The graduate will have an ability to manage and provide leadership in the ethical considerations of military acquisition, including the provisions of procurement integrity, and to appropriately apply defense acquisition standards of conduct.

11. JOINT MARITIME AND STRATEGIC PLANNING: American and world military history and joint and maritime planning including the origins and evolution of national and allied strategy; current American and allied military strategies which address the entire spectrum of conflict; the U.S. maritime component of national military strategy; the organizational structure of the U.S. defense establishment; the role of the commanders of unified and specified commands in strategic planning; the process of strategic planning; joint and service doctrine, and the roles and missions of each in meeting national strategy.

12. THESIS: The graduate will demonstrate the ability to conduct independent research and analysis, and proficiency in presenting the results in writing and orally by means of a thesis and a command-oriented briefing appropriate to this curriculum.

EDUCATIONAL SKILL REQUIREMENTS SYSTEMS INVENTORY MANAGEMENT CURRICULUM (819)

- 1. MANAGEMENT FUNDAMENTALS - QUANTITATIVE ANALYSIS:** The graduate will have the skills to apply mathematical, statistical, accounting, economic and other state-of-the-art quantitative techniques and concepts to the solving of day-to-day military management problems as well as the capability to use these skills as participant in the long range strategic planning efforts of the Navy and DoD.
- 2. MANAGEMENT FUNDAMENTALS - ORGANIZATION AND MANAGEMENT:** The graduate will have a thorough knowledge of basic management theory and practices, embracing leadership, communication, organizational design, staffing, directing, planning and controlling of military organizations. These are essential for the officer graduate to be an effective leader in any of the agencies of the Navy and DoD.
- 3. INTEGRATED LOGISTICS SUPPORT MANAGEMENT:** The graduate will have a detailed understanding of the processes associated with designing an integrated support system for a new weapon system. The graduate will also have detailed knowledge about the DoD processes for contracting for and acquiring a new weapon system which has adequate integrated support.
- 4. BUDGETING AND FINANCIAL CONTROLS:** The graduate will have an understanding of the financial and management practices of DoD, will be able to conduct cost/benefit analyses, and participate in the budgetary planning by a hardware systems command for the support of both old and new weapon systems.
- 5. INVENTORY MANAGEMENT:** The graduate will have an in-depth understanding of inventory management theory and application within DoN and DoD. As a consequence, the graduate will be able to make decisions on the validity of new models and management procedures being proposed for use by the Joint Logistics Support Center, Navy and Defense Logistics Agency Inventory Control Points, Fleet and Industrial Supply Centers, and Fleet And Shore Based customers.
- 6. MATERIALS AND PHYSICAL DISTRIBUTION MANAGEMENT:** The graduate will be able to apply the techniques of material management and physical distribution management in designing and operating of fleet and troop support systems both during peacetime and during rapidly developing wartime contingencies. This will include acquiring material and transportation assets to insure that cost-effective and efficient.
- 7. JOINT AND MARITIME STRATEGIC PLANNING:** The graduate will have an understanding of the development and execution of military strategy, the effects of technical developments on warfare, the processes for formulating U.S. policy, the roles of military forces, joint planning and current issues in the defense organization.
- 8. THESIS:** The graduate will demonstrate the ability to conduct independent research and analysis, and proficiency in presenting the results in writing by means of a thesis appropriate to this curriculum.

EDUCATIONAL SKILL REQUIREMENTS MATERIAL LOGISTICS SUPPORT MANAGEMENT CURRICULUM (827)

- 1. MANAGEMENT FUNDAMENTALS - QUANTITATIVE ANALYSIS:** The graduate will have the skills to apply mathematical, statistical, accounting, economic and other state-of-the-art quantitative techniques and concepts to the solving of day-to-day military management problems as well as the capability to use these skills as a participant in the long range strategic planning efforts of the Navy and DoD.
- 2. MANAGEMENT FUNDAMENTALS - ORGANIZATION AND MANAGEMENT:** The graduate will have a thorough knowledge of basic management theory and practices, embracing leadership, communication, organizational design, staffing, directing, planning and controlling of military organizations.
- 3. INTEGRATED LOGISTICS SUPPORT MANAGEMENT:** The graduate will have a detailed understanding of the processes associated with designing an integrated logistics support system for a new weapon system. The graduate will also have detailed knowledge about the DoD processes for contracting for and acquiring a new weapon system. The graduate will be able to serve as an assistant program manager for logistics (APML) for a major weapon system.
- 4. BUDGETING AND FINANCIAL CONTROLS:** The graduate will have an understanding of the financial management practices of DoD, will be able to conduct cost/benefit analyses, and participate in the budgetary planning by a hardware systems command for the support of both old and new weapon systems.
- 5. PRODUCTION/OPERATIONS MANAGEMENT:** The graduate will be able to apply the techniques of production/operations management at Naval Aviation Intermediate Activities and Depots, Navy Fleet Industrial and Support Activities, and other DoD maintenance and maintenance support activities.
- 6. MATERIALS AND PHYSICAL DISTRIBUTION MANAGEMENT:** The graduate will be able to apply the techniques of material management and physical distribution management in designing and operating of fleet and troop support systems for both peacetime and rapidly developing wartime contingencies. This will include acquiring material and transportation assets to insure that the distribution of material is both cost-effective and efficient.
- 7. JOINT AND MARITIME STRATEGIC PLANNING:** The graduate will have an understanding of the development and execution of military strategy, the effects of technical developments on warfare, the processes for formulating U.S. policy, the roles of military forces, joint planning and current issues in the defense organization.
- 8. THESIS:** The graduate will demonstrate the ability to conduct independent research and analysis, and proficiency in presenting the results in writing by means of a thesis appropriate to this curriculum.

EDUCATIONAL SKILL REQUIREMENTS FINANCIAL MANAGEMENT CURRICULUM (837)

1. **MANAGEMENT FUNDAMENTALS:** The graduate will have the ability to apply quantitative, accounting, economics, information technology, and other state-of-the-art management techniques and concepts to military management problems. Also, the graduate will know basic management theory and practices, embracing leadership, communication, organization design, staffing, quality, and planning within large private and public sector organizations, as well as military subunits and activities.
2. **FEDERAL AND DEFENSE BUDGETING:** The graduate will understand the roles of the executive and legislative branches in setting federal fiscal policy, allocating resources to national defense, budget formulation, negotiation, and execution strategies. In addition, the graduate will have knowledge of all aspects of the federal, Defense, and Navy budget cycles including the Planning, Programming, and Budgeting System with emphasis on budget formulation and execution.
3. **MANAGING FUNDS:** In support of approved programs, the graduate will be able to manage appropriated, revolving, and nonappropriated funds in compliance with regulations of the Comptroller of the Navy and the federal government. Also, the graduate will be able to develop and review financial reports, analyze budget execution against operating and financial plans, develop alternate plans based on analyses of an activity's financial performance, and prepare recommendations or make decisions regarding the reallocation or reprogramming of funds. The guidelines of the Defense Financial Accounting Systems and the Federal Accounting Standards Advisory Board are relevant.
4. **INTERNAL CONTROL AND AUDITING:** In accordance with the auditing standards of the U.S. General Accounting Office, the Defense and Navy audit organizations, and the professional standards of the American Institute of Certified Public Accountants, the graduate will learn to apply audit procedures and techniques that enforce sound internal accounting and administrative controls, safeguard defense assets, and assure the completeness and integrity of financial reports.
5. **ACQUISITION MANAGEMENT:** The graduate will understand the purpose and concepts of the Defense systems acquisition process and the application of project management methods within this process.
6. **ECONOMY, EFFICIENCY, AND EFFECTIVENESS:** The graduate will have the skills for solving complex and unstructured management problems in which alternatives must be identified, evaluated, and selected in accordance with economical procurement of resources, efficient utilization of resources, and effective accomplishment of overall Defense and Navy goals and objectives. This includes cost/benefit analysis, systems analysis, cost estimation, and application of relevant Defense instructions.

- 7. COST MANAGEMENT AND ANALYSIS:** The graduate will be able to design, implement, and evaluate different costing systems encountered within Defense and Navy organizations and activities as well as those found in private sector organizations conducting business with the federal government. In addition to private sector cost management policies and practices, the graduate will understand the application of Defense unit costing guidelines to functional business areas, and the Office of Management and Budget's Cost Accounting Standard for major suppliers of goods and services to the federal government.
- 8. STRATEGIC PLANNING AND CONTROL:** The graduate will have knowledge of strategic planning and management control concepts for setting goals and objectives; designing programs to achieve objectives; assigning individual responsibility for resource management, actions, and decision making; measuring performance; reporting results; and evaluating and rewarding performance. The graduate will be able to assess existing management systems and determine appropriate policies, procedures, organization structure, and information systems to ensure optimal use of available human, physical, and financial resources to satisfy the mission.
- 9. JOINT AND MARITIME STRATEGIC PLANNING:** American and world military history and joint and maritime planning including the origins and evolution of national and allied strategy; current American and allied military strategies which address the entire spectrum of conflict; the U.S. maritime component of national military strategy; the organizational structure of the U.S. defense establishment; the role of the commanders of unified and specified commands in strategic planning; the process of strategic planning; joint and service doctrine, and the roles and missions of each in meeting national strategy.
- 10. INNOVATION AND CREATIVITY:** The graduate will demonstrate initiative and creativity in performing independent research. This includes specifying research questions, formulating a research program, performing the research, and presenting the results in writing and orally by means of a thesis and command-oriented briefing appropriate to the financial management curriculum.

EDUCATIONAL SKILL REQUIREMENTS MANPOWER, PERSONNEL AND TRAINING ANALYSIS CURRICULUM (847)

- 1. MANAGEMENT FUNDAMENTALS - ORGANIZATION AND MANAGEMENT.** The graduate will have the ability to apply contemporary management principles, organization theory, and social science methodology to the management of human resources and to the development, implementation, and management of effective MPT policies and programs throughout DoN/DoD.
- 2. MANAGEMENT FUNDAMENTALS - QUANTITATIVE ANALYSIS:** The graduate will have the skills to apply mathematical, statistical, accounting, economic and other state-of-the-art quantitative techniques and concepts to the solving of day-to-day military management problems as well as the capability to use these skills as a participant in the long range strategic planning efforts of the Navy and DoD.
- 3. ADVANCED QUANTITATIVE ANALYSIS.** The graduate will have the ability to apply complex econometric techniques in the quantitative analysis of large scale DoN/DoD personnel data bases, and to utilize advanced Markov models in the analysis of force structure and manpower planning, forecasting, and flow models.
- 4. BUDGETING AND FINANCIAL CONTROLS.** The graduate will have an understanding of basic financial management practices and cost-benefit analysis. The graduate will have an understanding of the Planning, Programming, and Budgeting System (PPBS) and the ability to analyze the impact of budgetary changes on DoN/DoD manpower and personnel programs and policies.
- 5. AUTOMATED DATA ANALYSIS.** The graduate will have the ability to use and understand computer systems in problem solving and in the analysis of existing and proposed DoN/DoD management information systems.
- 6. MANPOWER, PERSONNEL AND TRAINING ANALYSIS-FUNDAMENTAL CONCEPTS.** The graduate will have an understanding of the fundamental concepts and basic functional areas of Manpower, Personnel and Training (MPT) within DoN/DoD including:

MANPOWER: Requirements determination (authorizations, billet costs, end strength development, mobilization) and the relationship to defense planning, programming, budgeting and acquisition processes.

PERSONNEL: Recruiting and enlistment process and standards, DoN enlisted force management system, officer community management; attrition and retention issues; compensation issues.

TRAINING: Theory of training, evolving instructional technology; evaluation of training effectiveness and cost; relationship between training and fleet readiness.

- 7. MANPOWER, PERSONNEL AND TRAINING ANALYSIS-POLICY ANALYSIS.** The graduate will have the ability to analyze critically the strengths and weaknesses of proposed MPT policies and to suggest alternatives that recognize the potential impact on DoN/DoD program planning, resources, and objectives.
- 8. JOINT AND MARITIME STRATEGIC PLANNING:** The graduate will have an understanding of the development and execution of military strategy, the effects of technical developments on warfare, the processes for formulating U.S. policy, the roles of military forces, joint planning and current issues in the defense organization.
- 9. EVALUATION, INNOVATION AND CREATIVITY.** The graduate will demonstrate individual initiative and creativity in the application of the skills and knowledge gained from the Manpower, Personnel, and Training Analysis program. The graduate will select a manpower, personnel, or training policy or management issue of importance to the Navy or DoD, develop a plan to investigate the issue, analyze all of its aspects, suggesting a solution as appropriate, and report the significant findings and recommendations to senior managers. The results will be presented in writing by means of a thesis.

UNDERSEA WARFARE, SPACE SYSTEMS, AND ELECTRONIC WARFARE PROGRAMS

Curricular Officer:

Robert Young
CDR, USN
Code 37, Root Hall
Room 103J
(408) 656-2135/6
DSN 878-2135/6

SPACE SYSTEMS OPERATIONS CURRICULUM 366

The Space Systems Operations curriculum is designed to provide officers with an appreciation for military opportunities and applications in space, comprehensive, practical as well as theoretical knowledge of the operation, tasking and employment of space surveillance, communications, navigation and atmospheric/oceanographic/environmental sensing systems and a knowledge of payload design and integration.

SPACE SYSTEMS (INTERNATIONAL)

A course of study modeled after Curriculum 366 or 591 is available for international students. Further information is available from the Curricular Officer or Academic Associate.

REQUIREMENTS FOR ENTRY

This curriculum is open to officers of the U.S. Armed Forces and selected civilian employees of the U.S. Federal Government. Admission requires a baccalaureate degree with above-average grades, completion of mathematics through differential and integral calculus, plus at least one course in calculus-based physics. Students lacking this background may matriculate through the Engineering Science program (Curriculum 460). A TOP SECRET security clearance is required with SPECIAL INTELLIGENCE (SI) clearance obtainable. International students require a minimum TOEFL of 540 (500-539 with supplemental language training).

SPACE SYSTEMS OPERATIONS SUBSPECIALTY

Completion of this curriculum qualifies an officer as a Space Systems Operations Subspecialist with a subspecialty code of XX76P. The curriculum sponsor is N63, Navy Space Systems Division.

Typical Jobs in this Subspecialty

OPNAV (N63) TENCAP Assistant
SPAWAR Space Systems Project Officer
NAVSPACECOM Staff Officer
USSPACECOM Staff Officer
NAVSECGRUs/DETs

ENTRY DATES

The Space Systems Operations curriculum is an eight-quarter course of study with a single entry date in October. If further information is needed, contact the Academic Associate or Curricular Officer.

Curriculum 366

Academic Associate:

Dan C. Boger, Professor
Code AS/Bo, Ingersoll Hall, Room 241
(408) 656-2607, DSN 878-2607

DEGREE

Requirements for the degree Master of Science in Systems Technology [Space Systems

Operations] are met as a milestone en route to satisfying the Educational Skill Requirements of the curricular program.

TYPICAL COURSE OF STUDY

Quarter 1

| | | |
|--------|-------|-------------------------|
| MA1118 | (5-3) | Multi-variable Calculus |
| OS2103 | (4-1) | Applied Probability |
| CS3020 | (4-0) | Software Engineering |
| SS2001 | (4-0) | Introduction to Space |

Quarter 2

| | | |
|--------|-------|---|
| EO2413 | (4-2) | Analog Signals and Systems |
| OS3604 | (4-0) | Decision and Data Analysis |
| CS3030 | (4-0) | Computer Architecture and Operating Systems |
| PH1322 | (4-0) | Electricity and Magnetism |

Quarter 3

| | | |
|--------|-------|-----------------------------------|
| EO2503 | (4-2) | Digital Signals and Systems |
| OS3008 | (4-0) | Analytical Planning Methodology |
| CC3111 | (4-0) | C3 Missions and Organizations |
| PH2511 | (4-0) | Introduction to Orbital Mechanics |

Quarter 4

| | | |
|--------|-------|---------------------------------------|
| EO3503 | (4-0) | Communications Systems Analysis |
| MN3301 | (4-0) | Systems Acquisition |
| SS3001 | (3-2) | Military Applications of Space |
| PH2514 | (4-0) | Introduction to the Space Environment |

Quarter 5

| | | |
|--------|-------|---------------------------------------|
| IS3502 | (3-2) | Computer Networks: Wide/Local Area |
| OS3603 | (4-0) | Simulation and Wargaming |
| AE4830 | (4-1) | Spacecraft Systems |
| NS3252 | (2-0) | Joint and Maritime Strategic Planning |

Quarter 6

(First six weeks)

| | | |
|--------|-------|----------------------------|
| SS4001 | (4-0) | Decision and Space Systems |
| SS3525 | (3-2) | Remote Sensing |

(Last six weeks)

| | | |
|--------|-------|----------------------------|
| EX0001 | (0-8) | Experience Tour Off Campus |
|--------|-------|----------------------------|

Quarter 7

| | | |
|---------|-------|------------------------------|
| AE 4831 | (4-0) | Spacecraft Systems II |
| SS4002 | (4-0) | Military Operations in Space |
| ST0810 | (0-8) | Thesis |
| | (0-8) | Specialization Elective |

Quarter 8

| | | |
|--------|-------|-------------------------|
| ST0810 | (0-8) | Thesis |
| ST0810 | (0-8) | Thesis |
| | (4-0) | Specialization Elective |
| | (4-0) | Specialization Elective |

UNDERSEA WARFARE

CURRICULUM 525

The Undersea Warfare Curriculum educates officers in the engineering fundamentals, physical principles and analytical concepts that govern operational employment of undersea warfare (USW) sensors and weapons. This interdisciplinary program divides naturally into four major academic areas, allowing the student to specialize in the area

of choice and to complete a Master of Science in Engineering Acoustics (with emphasis on underwater acoustics and weapons effects), Physical Oceanography (with emphasis on environmental factors affecting acoustic surveillance), Electrical Engineering (with emphasis on signal processing), Operations Research (with emphasis on tactical applications and decision analysis), Applied Mathematics or in other disciplines depending on the student's academic background.

UNDERSEA WARFARE (INTERNATIONAL)

A course of study modeled after curriculum 525 is available for international students. Further information is available from the Curricular Officer or Academic Associate. TOEFL is required.

REQUIREMENTS FOR ENTRY

A baccalaureate degree, or equivalent, from a program with a calculus sequence and a calculus-based physics sequence that results in an APC of 323 is required for direct input. Courses in the physical sciences and engineering are desirable. Officers not meeting the academic requirements for direct input enter the program via one or two quarters of Engineering Science (Curriculum 460).

UNDERSEA WARFARE SUBSPECIALTY

Completion of this curriculum qualifies an officer as an Undersea Warfare Subspecialist with a subspecialty code of XX44P. The curriculum sponsors are N87 (Submarine Warfare) and N85 (Expeditionary Warfare).

Typical Jobs in this Subspecialty:

| | |
|---|---------------------------------------|
| Naval Undersea Warfare Center | Submarine Development Squadron Twelve |
| Naval Air Warfare Center | Patrol Wing Staffs |
| Program Executive Offices | Naval Air Systems Command |
| Carrier Group Staffs | OPNAV |
| Naval Surface Warfare Development Group | |
| Fleet Mine Warfare Training Center | Destroyer Squadron Staffs |
| COMINELWARCOM | Operational Test and Evaluation Force |

ENTRY DATES

The Undersea Warfare curriculum is an eight-quarter course of study with entry dates in April and October. If further information is needed, contact the Academic Associate or Curricular Officer.

Curriculum 525

Academic Associate:

James V. Sanders, Assoc. Professor
Code 33A, Spanagel Hall, Room 328
(408)656-2116, DSN 878-2116

DEGREE

Specialization options within the core interdisciplinary program offer the opportunity to satisfy degree requirements for Master of Science in Engineering Acoustics, Physical Oceanography, Electrical Engineering, Applied Mathematics, Operations Research or other disciplines, depending upon academic qualifications, the specialization sequence selected, and the thesis. Students complete two quarters of study prior to electing a specialization track. Requirements for the degree Master of Science in Applied Science are met as a milestone en route to satisfying the Educational Skill Requirements of the curricular program.

TYPICAL COURSE OF STUDY

Quarter 1

| | | |
|--------|-------|--|
| MA2138 | (5-0) | Multivariable Calculus and Vector Analysis |
| MA2121 | (4-0) | Differential Equations |
| PH2119 | (4-2) | Oscillation and Waves |
| EC2400 | (3-2) | Discrete Signals and Systems |

Quarter 2

| | | |
|--------|-------|---|
| MA3139 | (4-0) | Fourier Analysis and Partial Differential Equations |
| OS2103 | (4-1) | Applied Probability |
| OC3230 | (3-1) | Descriptive Oceanography |
| EC2410 | (3-0) | Analysis of Signals and Systems |

Quarter 3

| | | |
|--------|-------|----------------------------|
| OS3303 | (4-1) | Computer Simulation |
| OS3604 | (4-0) | Decision and Data Analysis |
| OC3240 | (3-1) | Ocean Dynamics I |
| | (4-0) | Specialization Elective |

Quarter 4

| | | |
|--------|-------|---------------------------------------|
| OS3601 | (4-0) | Search, Detection, and Localization |
| OS3252 | (4-0) | Joint and Maritime Strategic Planning |
| PH3451 | (4-2) | Fundamental Acoustics |
| | (4-0) | Specialization Elective |

Quarter 5

| | | |
|--------|-------|---------------------------|
| OA4607 | (4-1) | Tactical Decision Aids |
| EC3400 | (4-0) | Digital Signal Processing |
| PH3452 | (4-2) | Underwater Acoustics |
| | (4-0) | Specialization Elective |

Quarter 6

| | | |
|--------|-------|----------------------------------|
| OC3266 | (3-2) | Operational Acoustic Forecasting |
| PH3479 | (4-0) | Physics of Underwater Weapons |
| ST0810 | (0-8) | Thesis |
| EC4450 | (4-0) | Specialization Elective |

Quarter 7

| | | |
|--------|-------|----------------------------|
| PH3052 | (3-1) | Space and Airborne Sensors |
| PH3001 | (4-0) | Undersea Warfare Sensors I |
| ST0810 | (0-0) | Thesis |
| | (4-0) | Specialization Elective |

Quarter 8

| | | |
|--------|-------|---------------------------|
| EC4450 | (4-1) | Sonar Systems Engineering |
| ST0810 | (0-0) | Thesis Research |
| ST0810 | (0-8) | Thesis Research |
| | (4-0) | Specialization Elective |

**SPACE SYSTEMS ENGINEERING
CURRICULUM 591**

The Space Systems Engineering program provides officers, through graduate education, with a comprehensive scientific and technical knowledge of military and Navy space systems. This curriculum is designed to equip officers with the theoretical and practical skills required to design and integrate military space payloads with other spacecraft subsystems. Graduates will be prepared by their education to design, develop and manage the acquisition of space communications, navigation, surveillance, electronic warfare and environmental sensing systems.

REQUIREMENTS FOR ENTRY

A baccalaureate degree, or its equivalent, in engineering or the physical sciences is preferred. An APC of 323 is required for direct entry. The Engineering Science program (Curriculum 460) is available for candidates who do not meet all admission requirements. The additional time required will vary with the candidate's background. For those undertaking the electrical engineering program, the officer will have earned the equivalent of an accredited BSEE. A TOP SECRET security clearance is required with SPECIAL INTELLIGENCE (SI) clearance obtainable for all students. TOEFL is required for international students.

SPACE SYSTEMS ENGINEERING SUBSPECIALTY

Completion of this curriculum qualifies an officer as a Space Systems Engineering Specialist with a subspecialty code of XX77P. The curriculum sponsor is N-63, Navy Space Systems Division.

Typical Jobs in this Subspecialty:

Assistant Project Manager Satellite Communications: SPAWAR

Assistant for Navigation Systems: CNO N-6 Staff

MILSTAR Systems Engineering: Navy Space Systems Activity, Los Angeles, CA

Launch and Control Systems Officer: Naval Space Command

Department Head: Navy Astronautics Group, Pt. Mugu, CA

ENTRY DATES

Space Systems Engineering is a nine-quarter course of study with entry dates in April and October. If further information is needed, contact the Academic Associate or the Curricular Officer.

Curriculum 591

Academic Associate:

Oscar Biblarz, Professor

Code AA/Bi, Halligan Hall, Room 234

(408) 656-3096, DSN 878-3096

DEGREE

Requirements for one of three technical degrees are met as a milestone en route to satisfying the Educational Skill Requirements of this curricular program. The possible degrees are: Master of Science, Electrical Engineering, Physics or Astronautical Engineering. Degrees in other disciplines are available for students with appropriate backgrounds, on a case by case basis.

TYPICAL COURSE OF STUDY

Quarter 1

| | | |
|--------|-------|---------------------------------|
| MA2121 | (4-0) | Differential Equations |
| PH1322 | (4-1) | Electricity and Magnetism |
| EC2820 | (3-2) | Digital Logic Circuits |
| CS2970 | (4-1) | Structured Programming with ADA |

Quarter 2

| | | |
|--------|-------|-----------------------------------|
| PH2514 | (4-0) | Introduction to Space Environment |
| PH2511 | (4-0) | Orbital Mechanics |
| EC2400 | (3-0) | Discrete Systems |
| EC2410 | (3-0) | Fourier Analysis |

Quarter 3

| | | |
|--------|-------|--------------------------|
| XXXXXX | (4-0) | Track Option |
| EC2420 | (3-0) | Linear Systems |
| XXXXXX | (4-0) | Track Option |
| PH3360 | (4-1) | EM Waves and Propagation |

Quarter 4

| | | |
|--------|-------|----------------------------------|
| EC2300 | (3-2) | Control Systems |
| EC2500 | (3-2) | Communications Theory |
| XXXXXX | (4-0) | Track Option |
| SS3001 | (4-0) | Space Warfare Systems Operations |

Quarter 5

| | | |
|--------|-------|-----------------------|
| AA3851 | (3-2) | Spacecraft Propulsion |
| AA3815 | (4-0) | Spacecraft Dynamics |
| XXXXXX | (4-0) | Track Option |
| AE2820 | (3-2) | Spacecraft Structures |

Quarter 6

| | | |
|--------|-------|--------------------------|
| EO3740 | (3-0) | Space Power |
| AA3804 | (2-0) | Thermal Control |
| SS3525 | (3-2) | Remote Sensing |
| | | Six Week Experience Tour |

Quarter 7

| | | |
|--------|-------|-----------------------------------|
| SS3035 | (3-2) | Microprocessors |
| AA4818 | (3-1) | S/C Attitude Dynamics and Control |
| XXXXXX | (4-0) | Track Option |
| SS0810 | (0-8) | Thesis |

Quarter 8

| | | |
|--------|-------|---------------------------------------|
| NS3252 | (4-0) | Joint and Maritime Strategic Planning |
| AA4870 | (4-0) | Spacecraft Design I |
| XXXXXX | (4-0) | Track Option |
| SS0810 | (0-8) | Thesis |

Quarter 9

| | | |
|--------|-------|----------------------|
| MN3301 | (4-0) | Systems Acquisition |
| AA4871 | (4-0) | Spacecraft Design II |
| SS0810 | (0-8) | Thesis |
| SS0810 | (0-8) | Thesis |

**ELECTRONIC WARFARE
CURRICULUM 595**

This curriculum provides the services with officers thoroughly knowledgeable in the technical and operational aspects of the role of electronic warfare as a vital, integral part of modern warfare. It is designed to provide an understanding of the principles underlying the broad field of electronic warfare and because of the electronic nature of modern sensor, weapon, and command, control and communications systems, it seeks to develop in the officer a grasp of electronic, electrical and electromagnetic fundamentals, theory and techniques.

REQUIREMENTS FOR ENTRY

Students wishing to undertake studies in this curriculum require a baccalaureate degree with above-average grades and completion of mathematics courses through differential and integral calculus. Those lacking the background may matriculate via the Engineering Science Program (Curriculum 460). An APC of 324 is required for direct entry.

ELECTRONIC WARFARE SUBSPECIALTY

Completion of this curriculum qualifies an officer as an Electronic Warfare Subspecialist with a code of XX46P. The Curriculum Sponsor is N64, Command and Control Warfare Division.

Typical Jobs in this Subspecialty:

Fleet and Group Staffs
Systems Commands
Naval Security Groups/Dets
U.S. Space Command
Operational Test and Evaluation Force
Joint Electronic Warfare Center
OPNAV

ENTRY DATE

This Electronic Warfare Curriculum is an eight-quarter course of study with a single entry date in October. If further information is needed, contact the Academic Associate for this curriculum.

Curriculum 595

Academic Associate:

David Jenn, Associate Professor
Code EC/Jn, Spanagel Hall, Room 414
(408) 656-2254, DSN 878-2254

DEGREE

Requirements for the degree Master of Science in Systems Engineering are met as a milestone en route to satisfying the Educational Skill Requirements of the curricular program.

TYPICAL COURSE OF STUDY

Quarter 1

| | | |
|--------|-------|--|
| PH2911 | (3-2) | Introduction to Computational Physics |
| MA2138 | (5-0) | Multivariable Calculus and Vector Analysis |
| MA2121 | (4-0) | Differential Equations |
| PH2203 | (4-0) | Topics in Basic Physics: Waves and Optics |

Quarter 2

| | | |
|--------|-------|---|
| EO2170 | (4-2) | Introduction to Electrical Engineering |
| OS2103 | (4-1) | Applied Probability for Systems Technology |
| MA3139 | (4-0) | Fourier Analysis and Partial Differential Equations |
| EO2602 | (4-0) | Introduction to Fields and Waves |

Quarter 3

| | | |
|--------|-------|--------------------------------|
| EO2402 | (4-1) | Introduction to Linear Systems |
| OS3604 | (4-0) | Decision and Data Analysis |
| EO2770 | (3-1) | Electromagnetic Engineering |
| PH2207 | (4-0) | Fundamentals of Electro-Optics |

Quarter 4

| | | |
|--------|-------|---|
| EO4612 | (4-2) | Microwave Devices and Radar |
| PH3208 | (4-1) | Electro-Optics Principles and Devices |
| EO3402 | (4-0) | Signal Processing Systems |
| EO3602 | (4-1) | Electromagnetic Radiation, Scattering and Propagation |

Quarter 5

(First six weeks)

| | | |
|------------------|-------|--|
| MR2416 | (2-0) | Meteorology for Electronic Warfare |
| OS3003 | (4-0) | Operations Research for Electronic Warfare |
| (Last Six Weeks) | | Experience Tour Off Campus |

Quarter 6

| | | |
|--------|-------|---|
| EO4622 | (3-2) | Electronic Warfare Systems |
| EO4602 | (3-1) | Electro-Optic Systems and Countermeasures |
| EC2820 | (3-2) | Digital Logic Circuits |
| EW0810 | (0-8) | Thesis Research |

Quarter 7

| | | |
|--------|-------|--|
| EO3802 | (3-2) | Electronic Warfare Computer Applications |
| OS4601 | (4-0) | Operational Test and Evaluation |
| EW0810 | (0-8) | Thesis Research |
| EW0810 | (0-8) | Thesis Research |

Quarter 8

| | | |
|--------|-------|---------------------------------------|
| EO3512 | (3-1) | Communication and Countermeasures |
| NS3252 | (4-0) | Joint and Maritime Strategic Planning |
| EW4910 | (4-0) | Space and Electronic Warfare |
| EW0810 | (0-0) | Thesis Research |

**ELECTRONIC WARFARE (INTERNATIONAL)
CURRICULUM 596**

The curriculum is modeled after Curriculum 595 and for the first three quarters exactly parallels the basic curriculum. In the second year, international students are channeled in courses similar in content to courses taught to U.S. students but without the classification level.

REQUIREMENTS FOR ENTRY

International students must meet the APC requirements and receive approval by the Director of Admissions at the Naval Postgraduate School. The procedures for application are contained under the Admissions heading in this catalog. TOEFL is required.

ENTRY DATES

This Electronic Warfare Curriculum is an eight-quarter course of study with an entry date in October. If further information is needed, contact the Academic Associate for this curriculum.

TYPICAL COURSE OF STUDY

Quarter 1

| | | |
|--------|-------|--|
| PH2911 | (3-2) | Introduction to Computational Physics |
| MA2138 | (5-0) | Multivariable Calculus and Vector Analysis |
| MA2121 | (4-0) | Differential Equations |
| PH2203 | (4-0) | Basic Physics: Waves and Optics |

Quarter 2

| | | |
|--------|-------|---|
| EO2170 | (4-2) | Introduction to Electrical Engineering |
| OS2103 | (4-1) | Applied Probability for Systems Technology |
| MA3139 | (4-0) | Fourier Analysis and Partial Differential Equations |
| EO2602 | (4-0) | Introduction to Fields and Waves |

Quarter 3

| | | |
|--------|-------|--------------------------------|
| EO2402 | (4-1) | Introduction to Linear Systems |
| OS3604 | (4-0) | Decision and Data Analysis |
| EO2612 | (3-1) | Electromagnetic Engineering |
| PH2207 | (4-0) | Fundamentals of Electro-Optics |

Quarter 4

| | | |
|--------|-------|---|
| EO3402 | (4-0) | Signal Processing Systems |
| PH3208 | (4-1) | Electro-Optic Principles and Devices |
| EC3600 | (3-2) | Electromagnetic Radiation, Scattering and Propagation |
| EC4620 | (4-2) | Microwave Devices and Radar |

Quarter 5

| | | |
|--------|-------|--|
| EC3610 | (3-2) | Microwave Circuits |
| OS3003 | (4-0) | Operations Research for Electronic Warfare |
| OS3303 | (4-1) | Computer Simulation |
| MR2416 | (2-0) | Meteorology for Electronic Warfare |

Quarter 6

| | | |
|--------|-------|-----------------------------------|
| EC4620 | (3-2) | Radar Systems |
| EC3620 | (3-2) | Microwave Devices |
| PH4209 | (3-2) | EO/IR Systems and Countermeasures |
| EW0810 | (0-8) | Thesis Research |

Quarter 7

| | | |
|--------|-------|--|
| EO3802 | (3-2) | Electronic Warfare Computer Applications |
| OS4601 | (4-0) | Test and Evaluation |
| EW0810 | (0-8) | Thesis Research |
| EW0810 | (0-8) | Thesis Research |

Quarter 8

| | | |
|--------|-------|---|
| EC4690 | (3-2) | Principles of Electronic Warfare Elective |
| EC3512 | (3-1) | Communications and Countermeasures |
| EW0810 | (0-8) | Thesis Research |
| IT1500 | (3-0) | American Life and Institutions |

EDUCATIONAL SKILL REQUIREMENTS SPACE SYSTEMS OPERATIONS CURRICULUM (366)

1. JOINT AND MARITIME STRATEGIC PLANNING

American and world military history and joint maritime planning including the origins and evolution of national and allied strategy; current American and allied military strategies which address the entire spectrum of conflict; the U.S. maritime component of national military strategy; the organizational structure of the U.S. defense establishment; the role of the commanders of unified and specified commands in strategic planning; the process of strategic planning; joint and service doctrine and the roles and missions of each in meeting national strategy.

2. MILITARY OPERATIONS INVOLVING SPACE

The ability to derive, assess, and articulate: cost-effective requirements for the design, performance, and operational use of space systems; strategies, plans, doctrine, tactics, and operational concepts for the employment of space systems; the nature of space warfare, including the options available to protect U.S. and Allied assets and to deny the hostile use of space to others; the roles, responsibilities, and relationships of national, DoD, and Navy organizations involved in the design, acquisition, and operation of space systems; the policies of these organizations governing the management of military operations in space; intelligence collection and analysis processes and information systems and their interactions with command and control systems.

3. COST EFFECTIVENESS AND ANALYTIC MODELING TECHNIQUES

An understanding of, and the ability to perform, cost-effective trade-offs involving alternate system concepts or system architectures, among elements of spacecraft design and system operations and tasking, including the space and terrestrial segments.

The ability, through simulation, modeling, and other analytic techniques, to evaluate the contribution of space systems to warfare and to determine and define the role of space systems in strategic and tactical command and control architectures at both Navy and national levels.

4. ORBITAL MECHANICS, SPACE ENVIRONMENT AND REMOTE SENSING

An understanding of the basic physics of orbital motion, the parameters used in the description of orbits and their ground tracks and how orbits are achieved. Perturbations due to non-spherical earth and due to atmospheric drag. Relationships of orbits to mission requirements.

An understanding of the natural and induced environment of space including solar activity, geomagnetic and magnetospheric phenomena, physics of the ionosphere and upper atmosphere and their response to natural and artificial disturbances.

An understanding of the principles of active and passive sensors used in spacecraft for sensing through the atmosphere. Knowledge of the effects of the space environment and countermeasures on sensor performance. An understanding of tradeoffs among various sensor techniques, including area of coverage, resolution, processing, and power requirements.

5. PROJECT MANAGEMENT

An understanding of project management and defense system acquisition methods and procedures to include organizational responsibilities and relationships; financial management and control; and the planning, programming, and budgeting system (PPBS).

6. COMPUTER SYSTEMS

General knowledge of the design and operation of computer systems, to include basic computer organization and architecture, software engineering and database management methodologies, and a rudimentary skill in at least one widely used high-level programming language, including ADA.

7. COMMUNICATION SYSTEMS

A systems level understanding of digital and analog communications systems and their integration into a complete, networked communication system in multiple environments to include C3CM and electronic warfare.

8. SPACECRAFT DESIGN AND SYSTEMS INTEGRATION

A basic understanding of the major factors in and constraints on spacecraft design, including guidance and control, dynamics and structures, propulsion and power, and thermal control, and their interactions with the remainder of the space and terrestrial segments.

9. CONDUCT AND REPORT INDEPENDENT RESEARCH

The graduate will demonstrate the ability to conduct independent analysis in space systems operations and proficiency in presenting the results in writing and orally

EDUCATIONAL SKILL REQUIREMENTS UNDERSEA WARFARE CURRICULUM (525)

1. PHYSICS:

The officer will understand physical principles applicable to acoustic, non-acoustic USW systems and underwater weapons systems.

2. ACOUSTICS

The officer will understand acoustical phenomena affecting the design, performance, and operation of acoustic USW systems.

3. OCEANOGRAPHY AND METEOROLOGY

The officer will understand atmospheric and oceanographic processes influencing the performance and tactical use of USW systems.

4. SIGNAL PROCESSING

The officer will understand principles of signal processing as they apply to USW systems.

5. OPERATIONS RESEARCH AND SYSTEMS TECHNOLOGY

The officer will understand computer simulation; search, detection, and localization; and USW modeling.

The officer will understand principles of data analysis in the evaluation of USW systems.

The officer will understand tactical decision aids for USW systems.

6. JOINT AND MARITIME STRATEGIC PLANNING

The officer will have a knowledge of American and world military history and joint and maritime planning including the origins and evolution of national and allied strategy; current American and allied military strategies which address the entire spectrum of conflict; the U.S. maritime component of national military strategy; the organizational structure of the U.S. defense establishment; the role of the commanders of unified and specified commands in strategic planning, the process of strategic planning; joint and service doctrine, and the roles and missions of each in meeting national strategy.

7. PROBLEM SOLVING AND PRACTICAL APPLICABILITY

The graduate will demonstrate the ability to conduct independent analysis in undersea warfare and proficiency in presenting the results in writing and orally by means of a thesis and command-oriented briefing.

EDUCATIONAL SKILL REQUIREMENTS SPACE SYSTEMS ENGINEERING CURRICULUM (591)

1. JOINT & MARITIME STRATEGIC PLANNING

American and world military history and joint and maritime planning including the origins and evolution of national and allied strategy; current American and allied military strategies which address the entire spectrum of conflict; the U.S. maritime component of national military strategy; the organizational structure of the U.S. defense establishment; the role of the commanders of unified and specified commands in strategic planning; the process of strategic planning; joint and service doctrine, and the roles and missions of each in meeting national strategy.

2. ORBITAL MECHANICS, SPACE ENVIRONMENT & REMOTE SENSING

- (a) The student should possess an understanding of the basic physics of orbital motion, the parameters used in the descriptions of orbits, their ground tracks and how orbits are achieved, as well as the effect of orbit perturbations due to atmospheric drag and Earth oblations. Furthermore, the student should understand the sensitivity of these orbital laws, parameters and perturbations to typical military orbit requirements.
- (b) The officer will have a fundamental understanding of the environment of space, including solar activity, geomagnetic and magnetospheric phenomena, physics of the ionosphere and upper atmosphere and their response to natural and artificial disturbances. Furthermore, the student should understand the sensitivity of these space environment parameters on military space requirements.
- (c) The officer will possess an understanding of the principles of active and passive sensors used in spacecraft for sensing signals through the atmosphere. This understanding should include knowledge of the effects of the space environment and potential countermeasures on sensor performance, as well as potential tradeoffs among various sensor techniques, including area of coverage, resolution, processing and power requirements.

3. COMMUNICATIONS AND SIGNAL PROCESSING

- (a) The officer will have an understanding of the basic performance characteristics of communications and telemetry systems, both ground based and space based, for tracking military objects of interest, military telemetry and military command/status links.
- (b) The officer will have knowledge of fundamental signal processing techniques, both digital and analog, as utilized by military communications, surveillance and electronic warfare systems.

4. COMPUTERS: HARDWARE AND SOFTWARE

- (a) The officer will possess programming skills in at least one high level computer programming language, such as ADA, suitable for military computing applications.
- (b) The officer will possess an understanding of the fundamentals of digital logic and digital system design. Furthermore, the student should possess the ability to design simple digital computer subsystems for military applications.
- (c) The officer will have knowledge of a typical computer architecture, such as one of the common 16 bit or 32 bit microprocessor systems, as well as an understanding of the ways in which computers are used in complex military systems such as guidance, signal processing, communications and control systems.

5. SPACECRAFT GUIDANCE AND CONTROL

The officer will have fundamental knowledge of the field of attitude dynamics and control including classical Newtonian dynamics, 3 axis attitude stabilization, dual spin stabilization, nutation damping control, momentum wheels, gravity gradient booms, attitude beam pointing accuracy and thrust vector books and control. The student should also possess a fundamental knowledge of minimum fuel and time type control systems. The student should have particular knowledge of how these concepts can impact the design and operation of military spacecraft.

6. SPACECRAFT STRUCTURES, MATERIALS AND DYNAMICS

The officer will have a basic understanding of the engineering of space structures, including the simplified sizing calculation and analytical modeling of advanced materials which can be incorporated into military system design and integration. Furthermore, the officer should possess the ability to apply reliability and maintainability to testing, evaluation and manufacturing procedures, processes and methods which can be used to predict the functional dependability of military spacecraft structures.

7. PROPULSION SYSTEMS

The officer will have knowledge of the operating principles of current and proposed propulsion devices for military space applications; including launch, orbit changing and maneuvering engines. This knowledge should also include an understanding of the interaction between military mission requirements and corresponding propulsion requirements.

8. SPACECRAFT THERMAL CONTROL AND POWER

- (a) The officer will possess a fundamental understanding of heat transfer, particularly heat transfer by radiation, and of the variations in the radiative properties of surfaces with respect to wavelength and temperature.
- (b) The officer will possess a knowledge of the several sources of heat in space (solar, terrestrial, reflected solar, internal military vehicle generation) and their variation as a function of military vehicle orbit.
- (c) In addition, the officer will possess knowledge of major power generating systems for military spacecraft and their operating characteristics, including the performance of photovoltaic sources in both natural and artificial radiation environments. This knowledge should include an understanding of the role of energy storage devices in military power systems design.

9. SPACECRAFT DESIGN AND INTEGRATION

The officer will possess an understanding of the principles of spacecraft design and integration, including formulation of design criteria from stated military performance requirements, tradeoffs between payload and other spacecraft subsystems, and a familiarity with test and evaluation procedures for military spacecraft.

10. MILITARY OPERATIONS IN SPACE

The officer will possess an appreciation of space weapons, defense and warfare, including options available to protect space assets and to deny the use of space to others. The officer should, in addition, understand the role, responsibilities and relationships of national, DoD and Navy organizations involved in the design, acquisition and operation of space systems and with national policies governing military operations in space.

11. PROJECT MANAGEMENT

The officer will possess a knowledge of defense project management and defense system acquisition methods and procedures, including organizational responsibilities and relationships, financial management and control, and the planning, programming and budgeting system (PPBS).

12. CONDUCT AND REPORT INDEPENDENT RESEARCH

The graduate will demonstrate the ability to conduct independent analysis in space systems engineering and proficiency in presenting the results in writing and orally by means of a thesis and command-oriented briefing.

EDUCATIONAL SKILL REQUIREMENTS ELECTRONIC WARFARE CURRICULUM (595)

1. PHYSICS:

- A. The officer will understand the physical principles of generation, transmission, propagation, reception and processing of infrared and electro-optic signals.
- B. The officer will understand the operation of infrared and electro-optic EW systems.

2. ELECTRICAL ENGINEERING:

- A. The officer will understand the physical principles of generation, transmission, propagation, reception and processing of microwave and radio frequency signals.
- B. The officer will understand the operation of microwave and radio frequency EW systems.

- 3. METEOROLOGY:** The officer will understand the atmospheric processes influencing the performance and tactical use of EW systems.

- 4. COMPUTER TECHNOLOGY:** The officer will understand the tactical use of real time systems and develop models for simulation, gaming and tactical use.

- 5. OPERATIONS ANALYSIS:** The officer will understand the acquisition process and principles of test and evaluation; perform assessments of threats and warfare operational capabilities; translate operational requirements into technical specifications.

- 6. ELECTRONIC WARFARE:** The officer will understand the integration of EW with weapons systems, space systems and C3; understand the role of EW in warfare areas; employ real time intelligence, tactics and EW systems.

- 7. JOINT AND MARITIME STRATEGIC PLANNING:** American and world military history and joint and maritime planning including the origins and evolution of national and allied strategy; current American and allied military strategies which address the entire spectrum of conflict; the U.S. maritime component of national military strategy; the organizational structure of the U.S. defense establishment; the role of the commanders of unified and specified commands in strategic planning, the process of strategic planning; joint and service doctrine, and the roles and missions of each in meeting national strategy.

- 8. PROBLEM SOLVING AND PRACTICAL APPLICABILITY:** The graduate will demonstrate the ability to conduct independent analysis in electronic warfare and proficiency in presenting the results in writing and orally by means of a thesis and command oriented briefing.

DEPARTMENT OF AERONAUTICS AND ASTRONAUTICS

Chairman:

Daniel J. Collins
Professor
Code AA/Co, Halligan Hall
Room 139
(408) 656-2311
DSN 878-2311

Brij N. Agrawal, Professor of Aeronautics and Astronautics (1989)*; PhD, Syracuse University, 1970.

Robert E. Ball, Professor of Aeronautics and Astronautics (1967); PhD, Northwestern University, 1962.

Oscar Biblarz, Professor of Aeronautics and Astronautics (1968); PhD, Stanford University, 1968.

Stephen C. Brawley, Lecturer (1994); PhD, Naval Postgraduate School, 1993.

M.S. Chandrasekhara, Adjunct Professor and Assistant Director, Navy-NASA Joint Institute of Aeronautics (1987); PhD, University of Iowa, 1983.

Daniel J. Collins, Professor of Aeronautics and Astronautics (1967); PhD, California Institute of Technology, 1961.

Garth Hobson, Associate Professor of Aeronautics and Astronautics (1990); PhD, Pennsylvania State University, 1990.

Richard M. Howard, Associate Professor of Aeronautics and Astronautics (1987); PhD, Texas A & M University, 1987.

Isaac I. Kaminer, Assistant Professor of Aeronautics and Astronautics (1992); PhD, University of Michigan, 1992.

Gerald H. Lindsey, Professor of Aeronautics and Astronautics (1965); PhD, California Institute of Technology, 1966.

David W. Netzer, Professor of Aeronautics and Astronautics (1968); PhD, Purdue University, 1968.

Conrad F. Newberry, Professor of Aeronautics and Astronautics (1990); D.Env., University of California at Los Angeles, 1985.

Max F. Platzer, Professor of Aeronautics and Astronautics (1970); Dr. Tech. Science, Technical University of Vienna, Austria, 1964.

I. Michael Ross, Assistant Professor of Aeronautics and Astronautics (1990); PhD, Pennsylvania State University, 1990.

Sandra Scrivener, Assistant Professor of Aeronautics and Astronautics (1993), PhD, Pennsylvania State University, 1993.

Raymond P. Shreeve, Professor of Aeronautics and Astronautics (1971); PhD, University of Washington, 1970.

E. Roberts Wood, Professor of Aeronautics and Astronautics (1988); D. Eng, Yale University, 1967.

Edward Ming-Chi Wu, Professor of Aeronautics and Astronautics (1984); PhD, University of Illinois, 1965.

*The year of joining the Naval Postgraduate School faculty is indicated in parentheses.

The Department of Aeronautics and Astronautics provides advanced education in Aeronautical and Astronautical Engineering to develop technical subspecialists in the field. Upper division undergraduate and graduate courses are offered in aerodynamics, structures, guidance and control, flight mechanics, propulsion and design, with applications to rotary wing and fixed wing aircraft, missiles and spacecraft.

Students specializing in either Aeronautical Engineering (Curriculum 610) or Aeronautical Engineering/Avionics (Curriculum 611) receive the degree Master of Science in Aeronautical Engineering, as well as select students in Combat Systems Sciences and Technology (Curriculum 533). Students in the 533 curriculum may also get a Master of Science degree in Engineering Science with option in Aeronautics. A Master of Science degree in Astronautical Engineering is offered to students in Space Systems Engineering (Curriculum 591). Selected students may be eligible to pursue the degree Aeronautical and Astronautical Engineer or Doctor of Philosophy.

The Department of Aeronautics and Astronautics has been accredited by the Accreditation Board for Engineering and Technology since 1949.

REQUIREMENTS FOR STUDY OF AERONAUTICAL AND ASTRONAUTICAL ENGINEERING

The entrance requirement for study in the Department of Aeronautics and Astronautics generally is a baccalaureate in engineering earned with above-average academic performance. This requirement can be met by taking the equivalent of an undergraduate major in aeronautical engineering at NPS before embarking upon graduate study. This may require up to 2 1/2 years total to obtain the Master's degree. Students who have not majored in aeronautics, or who have experienced a significant lapse in continuity with previous academic work, will initially take preparatory courses in aeronautical engineering and mathematics at the undergraduate upper division level, which may extend through as much as the first three academic quarters. Final approval of programs leading to degrees in aeronautical engineering must be obtained from the Chairman, Department of Aeronautics and Astronautics.

Degree coverage specifically to be approved includes mathematics and basic science, engineering science, adequate laboratory and computer experience, and design, including at least one capstone graduate level design course.

MASTER OF SCIENCE IN AERONAUTICAL ENGINEERING

The Master of Science degree requires a minimum of 36-credit hours of graduate courses in aeronautical engineering, the physical sciences and/or mathematics. Of these 36 hours, at least 27 must be taken in the Department of Aeronautics, with at least 12 of the 27 at the 4000 level. Not less than 8 credit hours must be taken in other departments. In addition, students pursuing this degree must complete an acceptable thesis in aeronautical engineering. Approval of the thesis research topic and study program resides with the Chairman of the Department of Aeronautics and Astronautics.

In very exceptional circumstances, the thesis requirement may be waived by the Department Chairman, in which case 10 hours of 4000 level courses, normally in Aeronautical Engineering, will be required in addition to those specified above, increasing the total requirement to 46 quarter hours of graduate-level credits.

MASTER OF SCIENCE IN ENGINEERING SCIENCE

Students may elect Aeronautics or Astronautics as a specialization option and receive the degree Master of Science in Engineering Science. The program must include at least 36 credit hours of graduate work in engineering, science and mathematics, at least 12 of which must be at the 4000 level. Of these 36 hours at least 20, including work at the 4000 level, must be in the Department of Aeronautics and Astronautics. Cognizance over the specialization course sequences, thesis research areas and the degree resides with the Chairman of the Department of Aeronautics and Astronautics.

The program must contain at least 12 hours at the graduate level in courses other than those presented in the Department of Aeronautics and Astronautics.

The candidate must present an acceptable thesis on a topic which is given prior approval by the Department of Aeronautics and Astronautics. Final approval of the program leading to the Master of Science in Engineering Science with specialization in Aeronautics or Astronautics shall be obtained from the Chairman of the Department of Aeronautics and Astronautics.

MASTER OF SCIENCE IN ASTRONAUTICAL ENGINEERING

The Master of Science degree in Astronautical Engineering requires a minimum of 36 credit hours of graduate courses in astronautical engineering, the physical sciences and/or mathematics. Of these 36 hours, at least 27 must be taken in the Department of Aeronautics and Astronautics, with at least 12 of the 27 at the 4000 level. Not less than 8 credit hours must be taken in other departments. In addition, students pursuing this degree must complete an acceptable thesis in astronautical engineering. Approval of the thesis research topic and study program resides with the Chairman of the Department of Aeronautics and Astronautics.

AERONAUTICAL AND ASTRONAUTICAL ENGINEER

The degree Aeronautical and Astronautical Engineer is offered in the department of Aeronautics and Astronautics and requires a minimum of 72 hours of graduate course credit. The degree also requires a graduate QPR of 3.5, with hours distributed as follows: at least 39 credit hours must be at the 4000 level, of which at least three must be in mathematics; not less than 64 graduate credit hours shall be in the disciplines of engineering, physical science or mathematics; a minimum of 36 hours must be in the Department of Aeronautics and Astronautics and at least 12 hours must be in other departments. An acceptable thesis is required for the degree and six course equivalents, spread over four quarters, will be allowed in the program for it.

Formal application to work toward the degree must be made to the Department of Aeronautics and Astronautics prior to commencement of thesis research, and it is required that the applicant have a graduate QPR of 3.5, an approved program of study, a thesis advisor and an approved Engineer's Thesis research project.

Students admitted to work for the degree Aeronautical and Astronautical Engineer may satisfy requirements for the Master of Science in Aeronautical Engineering or the Master of Science in Astronautical Engineering degree concurrently. The respective master's degrees may be conferred at the time of completion of the requirements for that degree.

An appropriate allowance will be made for work performed while earning the master's degree at another institution, not to exceed the maximum waivers in required graduate level courses specified in Section 5.3 of the Academic Council Policy Manual. Final approval of the program leading to the degree Aeronautical and Astronautical Engineer shall be obtained for each student from the Chairman, Department of Aeronautics and Astronautics.

DOCTOR OF PHILOSOPHY AND DOCTOR OF ENGINEERING

The Department of Aeronautics and Astronautics offers programs leading to the doctorate in the fields of gas dynamics, flight structures, flight dynamics, propulsion, aerospace physics and aerospace vehicle design.

Entrance into the doctoral program may be requested by officers currently enrolled in the Aeronautical and Astronautical Engineers Degree Program who have sufficiently high standing. A departmental screening examination will be administered to those so requesting. The Department of Aeronautics and Astronautics also accepts officer students selected in the Navy-wide Doctoral Study Program and civilian students selected from employees of the United States Federal Government.

All applicants who are not already enrolled as students in the Department of Aeronautics and Astronautics shall submit current GRE results, transcripts of their previous academic and professional records to the Director of Admissions Code 62, Naval Postgraduate School, Monterey, California 93943-5100. Upon receipt, the application shall be reviewed by the Aeronautics and Astronautics Committee for Advanced Studies. Following a successful review, the candidate is admitted to work toward the Engineer's Degree as an interim step before being formally admitted to study for the doctorate. As soon as feasible, the student shall take a screening examination, which if successfully completed, will admit him or her to study for the doctorate. A doctoral committee will then be appointed to oversee the student's study and research program.

A distinctive feature of the program leading to the Doctor of Engineering degree is that the student's research may be conducted away from the Naval Postgraduate School in a cooperating laboratory or other installation of the Federal Government. The degree requirements are outlined in general school requirements for the doctor's degree.

In the event that a student is unable to finally satisfy the above requirements for the doctorate, but has in the course of his or her doctoral studies actually completed all of the requirements for the degree of Aeronautical Engineer, he or she shall be awarded the latter degree.

AERONAUTICAL LABORATORIES

Eight major laboratory divisions support instructional and research programs in subsonic aerodynamics, gas dynamics, rocket and ramjet propulsion, turbomachinery, computer-aided engineering, flight mechanics, structures, composite materials and space systems.

The Subsonic Aerodynamics Laboratory consists of two low-speed wind tunnels, a large continuous-flow visualization tunnel and a 15x20 inch water tunnel. Standard wind tunnel techniques are used in the 32x45 inch and 42x60 inch tunnels and helium bubble filaments are used in the 5x5x12 foot test section of the three-dimensional flow visualization tunnel.

The Gas Dynamics Laboratory includes a 4x4 inch blowdown supersonic wind tunnel, a cold driven, three-inch double-diaphragm shock tube, a 2x2x18 foot open-circuit oscillating flow tunnel and a vertically mounted, supersonic free jet. Laser interferometers, schlieren systems, hot wire anemometry and laser-doppler anemometers are used. Ruby, He-Ne, Argon and CO lasers are available. Extensive use is made of laser holography. An electro-hydrodynamic research facility permits studies of electric power generation, turbulence and fuel sprays into gas turbine combustors.

The Combustion Laboratory consists of an instrumented control room, a propellant evaluation laboratory, a high-pressure air facility and three test cells equipped with diagnostic apparatus and motor hardware for investigating solid, liquid, gaseous and hybrid rocket, solid fuel ramjet and gas turbine combustion. Vitiated air heaters are

used to generate temperatures to 1300°F. Several CW and one pulsed laser with holocamera, high-speed motion picture cameras, light scattering and transmission measurement systems, schlieren systems, sampling probes and a dark room equipped for holographic reconstruction and data retrieval are utilized.

The Turbo-Propulsion Laboratory (TPL) houses a unique collection of experimental facilities for research and development related to compressors, turbines and advanced air-breathing propulsion engine concepts. In a complex of specially designed concrete structures, one building, powered by a 750 HP compressor, contains 10x60 inch rectilinear and 4 to 8 foot diameter radial cascade wind tunnels and a large 3-stage axial research compressor for low speed studies. A two-component, automated traverse, LDV system is available for CFD code verification experiments. A second building, powered by a 1250 HP compressed air plant, contains fully instrumented transonic turbine and compressor rigs in explosion proof test cells. A spin-pit for structural testing of rotors to 50,000 RPM and 1800°F is provided. Model experiments and equipment for instrumentation development are located in a separate laboratory. Data acquisition from 400 channels of steady state and 16 channels of non-steady state measurements at up to 100kHz is controlled by the laboratory's HP 1000 series computer system. On-line reduction and presentation of data with time sharing terminals are available to multiple users. Terminals for HP 9845 and the central AMDAHL 5990-5N computers are available for data analysis or flow computation.

The Computational Instruction Laboratory consists of 15 SGI Indigos, 6 Sun workstations, and 15 microcomputer systems.

The Flight Mechanics Laboratory consists of a general-aviation flight simulator and the Unmanned Air Vehicle Flight Research Laboratory (UAV FRL). The simulator is used for teaching flight test engineering. The UAV FRL conducts flight research with scaled radio-controlled aircraft to study problems identified with current fleet UAVs and to test new concepts for manned and unmanned aircraft application. Research vehicles include fixed-wing, VTOL and rotary wing aircraft. The department's wind tunnels are also used for aircraft performance, stability and control measurements.

The Structural Test Laboratory contains testing machines for static and dynamic tests of materials and structures and a MTS electrohydraulic closed-loop machine for fatigue testing. Aircraft components as large as an actual aircraft wing are accommodated on a special loading floor where static and vibration tests are conducted. An adjacent strain gage and photo-elastic facility provides support to test programs and instruction in structural testing techniques.

The Mechanics of Materials for Composites Laboratory is equipped with fabrication and testing facilities for characterizing the mechanical behavior of fiber-reinforced composites. The fabrication facilities include an oven and press with provisions for computer control of temperature and pressure profile for fabrication of laminates and strands. The testing facilities include five mechanically driven universal testing machines for general testing and for life testing. These testing facilities are supported by a wide array of modern data acquisition instruments including computer-controlled data loggers, digital voltmeters, acoustic emission analyzer and laser diffraction instruments. Personal computers and a VAX-725 provide ample capacity for analytical interpretation of data and for model formulation.

The Dynamics and Nondestructive Evaluation Laboratory is equipped for research on vibration of structures, particularly lightweight components for space structures made from composite materials like graphite/epoxy. It contains shaker tables, a four channel FFT analyzer, microcomputers with model analysis software and associated accelerometer instrumentation. For the study of wave propagation in these structures, the laboratory has high-speed transient recorders, narrow and wideband transducers,

pulse generators and an arbitrary waveform generator. Static and fatigue loading of samples can be carried out on the 100 kip servo hydraulic MTS machine. The detection of flaw growth during a test can be accomplished using the acoustic emission analyzer. A 2x4 foot ultrasonic C-scan tank can be used for post-test imaging of internal damage. Phase locked loop and quadrature phase detector circuitry allow precise spatial location of flaws. This instrumentation can also be used for very accurate wavespeed measurements.

The Controls Laboratory presently consists of five experimental apparatuses with associated computers and graphic interfaces. Each experiment is a physical device which possesses, for example, input limitations, hysteresis effects and dead-space, among other effects. A computer interface and software program permits the design of a wide range of controllers for the experiments. The purpose of the laboratory is to improve understanding of control theory by design of controllers for physical devices.

The Avionics Lab is involved in the design, analysis and integration of the avionics systems for unmanned air vehicles. The Lab's five workstations and three PC's are equipped with the hardware & software necessary for the development of navigation, guidance & control algorithms, as well as the complete process of testing these algorithms; first on the nonlinear simulation, then on the hardware in-the loop simulation, and finally the flight test. The Lab is also getting involved in the design and real-time, 3D testing of cockpit display concepts.

SPACECRAFT LABORATORIES

There are three spacecraft laboratories within the department, viz., the FLTSATCOM laboratory, the Spacecraft Test Laboratory, and the Spacecraft Attitude Dynamics and Control Laboratory. The FLTSATCOM laboratory houses a qualification model of the Navy's communication satellite (which provides global UHF coverage) along with the associated hardware and software used to test the satellite's subsystems. The test laboratory contains a vibration shaker system and a thermal vacuum chamber system. The former is used for testing typical vibration loads on a spacecraft, and is capable of simulating both low frequency (swept sinusoidal) and random vibrations. The latter is used to test the operation of spacecraft materials/subsystems under the combined conditions of space vacuum (below 10^{-5} torr) and thermal environment. The third laboratory contains a scaled model of a generic flexible spacecraft and simulates the pitch motion. It is used to study the interaction between the attitude control and the dynamics of flexible spacecraft, where the flexibility may be due to structures and/or liquid propellants.

NAVY-NASA JOINT INSTITUTE OF AERONAUTICS

Through a Memorandum of Understanding with the Ames Research Center (ARC) of the National Aeronautics and Space Administration (NASA), a Joint Institute of Aeronautics was established in July 1986. The purpose of the Institute is to provide NPS students with opportunities to perform their thesis research in an ARC Laboratory, to involve NPS faculty and students in NASA scientific and engineering projects, to develop special courses and seminars for NPS and ARC scientists and engineers to refresh and strengthen professional knowledge at NPS and ARC, and to encourage the enrollment of federal employees for graduate study at NPS with the possibility of performing the thesis research at ARC. Information about research opportunities and admission procedures can be obtained from the Institute Director, Dr. M.F. Platzer, or the Assistant Director, Dr. M.S. Chandrasekhara.

COURSE OFFERINGS

AAR242 THERMODYNAMICS/FLUID MECHANICS REFRESHER (NO CREDIT). (Meets last six weeks of quarter). (5-0).

This course is intended for students returning to school after a prolonged absence and will be taught as refresher in the first quarter of attendance at NPS. It is assumed that the student previously had knowledge and skill in the subject. Topics to be covered

include the first and second laws of thermodynamics, entropy, perfect gas laws, conservation of mass/momentum/energy from a control-volume point of view with constant density, and external viscous flow including both laminar and turbulent.

AA261 SOLID MECHANICS REFRESHER (NO CREDIT).

(Meets last six weeks of qtr). (5-0).

This course is intended for the student returning to school after a prolonged absence and will be taken as a refresher in the first quarter of attendance at NPS. It is assumed that the student previously had knowledge and skill in the subject. Topics to be covered include centroids, moments of inertia, equation of motion, equilibrium and free body diagrams, energy, work bending and torsion, shear and moment distributions, stress and strain.

AA0020 AERONAUTICAL ENGINEERING PROGRAM PLANNING. (NO CREDIT) (0-1).

Oral presentations to prospective thesis students by the department faculty, covering thesis research opportunities in specialty areas of Aeronautical Engineering.

AA0810 THESIS RESEARCH. (0-8).

Represents an equivalent of one four hour course spent in thesis research. Every student working on a thesis will enroll in this course, and more than one call may be made for the course in any given quarter.

AA2015 ENGINEERING DYNAMICS. (3-2).

Kinematics and dynamics of particles, systems of particles, and rigid bodies in two dimensions; concepts of work, kinetic energy, potential energy, impulse and momentum.

PREREQUISITES: MA2121 and ME2501.

AA2021 INTRODUCTION TO FLIGHT STRUCTURES. (4-1).

Engineering analytical stress analysis methods for wing and fuselage structures, beginning with the field equations for solid bodies and specializing to calculations of multiaxial bending and shear stresses of composite structures, with temperature loading, in open and multicelled, closed sections. **PREREQUISITE:** ME2601

AA2035 BASIC AERODYNAMICS. (3-2).

Continuity/momentum equations; dimensional analysis; elementary flow representation of ideal incompressible flows; thin-airfoil theory and finite-wing theory; computational methods. **PREREQUISITE:** AA2042

AA2036 PERFORMANCE AND STATIC STABILITY. (3-2).

Concepts of aircraft thrust, power, range, endurance and energy management are developed with application to propeller-driven and jet-powered aircraft. Longitudinal and lateral-directional static stability and flight control principles are derived, with relevant issues such as canards and longitudinal instability considered. Applications of Navy aircraft (P-3, A-6, A-7, E-2C, F-14, F-16 and F/A-18) and needs for future military aircraft are treated. **PREREQUISITE:** AA2035

AA2042 FUNDAMENTALS OF THERMO & FLUID DYNAMICS. (3-2).

Properties of fluids. First and second laws of thermodynamics; entropy and reversibilities; equations of state; properties of pure substances. Principles of continuity, momentum and energy for incompressible and compressible fluids; control volume formulations; power cycles. Viscous flows in ducts; boundary layer concepts; flow separation and drag.

AA2043 FUNDAMENTALS OF GAS DYNAMICS. (3-2).

Concepts of compressible flows, adiabatic/isentropic flow; normal shocks, moving and oblique shocks, Prandtl-Meyer flow; Fanno and Rayleigh flow; introduction to reaction propulsion systems. **PREREQUISITE:** AE 2042.

AA2339 AEROSPACE SYSTEM DYNAMICS. (3-2).

A general class of frequency-domain-based control theories for aircraft and missile guidance and control are covered. Various feedback stabilization schemes are investigated with practical application to flight control system design. Concepts such as autopilot and attitude-hold control system design are developed.

AA2440 INTRODUCTION TO DIGITAL COMPUTATION. (3-2).

Introduction to system operations and program development on the AA department computer systems and the NPS mainframe. Programming methods and languages will be illustrated in the solutions of non-linear equations, polynomial interpolations, and numerical integration and differentiation techniques as found in aeronautical engineering. UNIX operating system will be introduced.

AA2801 AERO-LABORATORIES. (3-2).

An introduction to modern experimental techniques and instrumentation. Lectures and demonstrations in the use of sensing devices and data acquisition systems, data reduction and analysis, report writing. Selected experiments from all aeronautical disciplines. PREREQUISITES OR CONCURRENTLY: AA2021, AA2035, AA2043, and AA2015.

AA2820 INTRODUCTION TO SPACECRAFT STRUCTURES. (3-2).

Stress-strain analyses for beams and columns, buckling analysis of thin-walled structures, natural frequencies, modes shapes, and forced response due to sinusoidal excitation of spring-mass systems, materials for space structures, and spacecraft launch loads.

AA3101 FLIGHT VEHICLE STRUCTURAL ANALYSIS. (3-2).

Energy methods of analytical structural analysis applied to aircraft structures, buckling of stiffeners and longerons in the elastic and column buckling theory applied to stiffened and unstiffened wing skins; introduction to finite element theory through the truss, beam and constant strain triangle element. PREREQUISITE: AA2021.

AA3202 AIRCRAFT STRUCTURAL FAILURE, FRACTURE AND FATIGUE. (3-2).

Theories of yield and fracture for aircraft design limit loads and ultimate loads; stress-life and strain-life fatigue theories of crack initiation in aircraft structures subjected to realistic flight load spectra, using Neuber's approximation and incorporating the Miner concept of cumulative damage. Fatigue crack propagation concepts and Navy methods of fleet aircraft fatigue tracking and monitoring. PREREQUISITE: AA2021.

AA3251 AIRCRAFT COMBAT SURVIVABILITY. (4-1).

This course brings together all of the essential ingredients in a study of the survivability of fixed wing aircraft, rotary wing aircraft, and cruise missiles in a hostile (non nuclear) environment. The technology for increasing survivability and the methodology for assessing the probability of survival in a AAA/SAM/Laser environment are presented in some detail. Topics covered include: current and future threat descriptions; the mission/threat analysis; combat analysis of SEA and Mid-East losses; vulnerability reduction techniques and technology for the major aircraft systems; susceptibility reduction concepts, including, stealth; vulnerability, susceptibility and survivability assessment and trade-off methodology, and system safety. In-depth studies of the survivability of several fixed wing and rotary wing aircraft will be presented. (May be taken for 3 credits through self study as AE3250). PREREQUISITE: U.S. Citizenship and SECRET clearance.

AA3276 INTRODUCTION TO AVIONICS. (3-2).

This course will introduce the students to the general functional and system architecture of a typical avionics system. It will then proceed to discuss in greater detail the tools necessary to better understand such systems, such as deterministic and stochastic systems theory. These tools will then be used to present basic navigation and

guidance concepts such as GPS , inertial navigation, homing and proportional guidance. At each step the typical hardware implementations of these concepts will be given. The course will also include the discussion of basic discrete-time systems concepts used to analyze the overall stability and performance of a digital avionics system. **PREREQUISITES:** AA2339 or equivalent, EC2010 concurrent with AA4341 or permission of instructor.

AA3340 DYNAMIC STABILITY OF AEROSPACE VEHICLES. (3-2).

Eigenvalue-problem solutions for undamped and damped systems with free and forced responses are developed. Aircraft dynamic equations of motion are derived to analyze longitudinal and lateral-directional flight modes using state-space methods. Military aircraft problems considered include inertial cross-coupling, limit-cycle wing rock, and yaw damper feedback.

AA3402 HELICOPTER STABILITY AND CONTROL. (3-2).

This course introduces the student to the fundamentals of helicopter aeromechanics which includes: (1) aerodynamics; (2) dynamics; (3) vibrations; (4) aeroelasticity; and (5) controls. Aerodynamics of the helicopter. Hover and vertical flight. Actuator disk, momentum theory, blade element theory, tip loss, rotor flow states, autorotation, hover and forward flight analysis, rotor trim, and performance analysis. Helicopter dynamics, rotor blade motion and control, rotor-as-a-filter, blade dynamic response, coupled blade-fuselage response, ground and air resonance, vibration control devices, and higher harmonic control. **PREREQUISITES:** AA2015, AA2035.

AA3451 AIRCRAFT AND MISSILE PROPULSION. (3-2).

Overview of engine types. Introduction to rocket propulsion and performance prediction. Solid propellant selection, combustion and nozzle flow analyses for Sidewinder-type missiles. Ideal theory, design point selection and off-design performance of turbo-jet, ramjet, turbo-fan, turbo-prop and turbo-shaft engines. Application to multi-purpose fighter aircraft, ocean-surveillance aircraft and helicopter propulsion. Use of design and off-design computer codes. Basic analysis of engine components, including inlets, compressors and fans, combustors, turbines, after-burners and nozzles. **PREREQUISITE:** AA2043.

AA3501 AERODYNAMIC ANALYSIS. (3-2).

Aerodynamic analysis of subsonic and supersonic flight vehicles, including panel lattice methods as well as Euler and Navier-Stokes CFD methods. Linearized flow descriptions with compressibility. Discussion of sweep-back effects and area ruling; introduction to DATCOM methods. Boundary layer concepts for laminar and turbulent flows. Focus on aspects of importance to military applications. **PREREQUISITES:** AA2043, AA2035, MA3132.

AA3701 MISSILE AERODYNAMICS. (4 - 1).

Potential flow, thin-airfoil and finite wing theories. Linearized equations, Ackeret theory, Prandtl-Glauert transformations for subsonic and supersonic wings. Planform effects. Flow about slender bodies of revolution, viscous crossflow theory. **PREREQUISITE:** AA2043.

AA3705 AIR DEFENSE LETHALITY. (4-1).

This course examines the design and effectiveness of anti-aircraft guns and missiles, both surface based and airborne. The techniques and procedures for target detection, target tracking, and propagator flyout (both guided and ballistic) are presented and quantified. Target signatures for radar, IR, and visually directed systems are examined. The types of warheads and fuzes on small arms, anti-aircraft artillery, and guided missiles are presented. The vulnerability of the target to the damage mechanisms is examined, and the procedures for assessing the measures of target vulnerability are described. Total system lethality is evaluated by determining the probability of target kill given a single shot and given an encounter. Countermeasures used by the target for

reducing the air defense lethality are also described.

AA3802 AERONAUTICAL MEASUREMENT TECHNIQUES. (3-2).

Hands-on exposure to modern laboratories including measuring and evaluation techniques. Introduction to test facilities at NASA and aerospace industry relevant to research, development and testing phases (RDT&E) of military hardware. Topics vary somewhat from offering to offering but cover significant current laboratory work within aerospace disciplines. PREREQUISITE: AA2801.

AA3804 THERMAL CONTROL OF SPACECRAFT. (3-0).

Conduction, radiation, thermal analysis, isothermal space radiator, lumped parameter analytical model, spacecraft passive and active thermal control, heat pipes, and louvers.

AA3811 SPACE SYSTEMS LABORATORY. (1-2).

Principles of spacecraft test programs; component, subsystem, and system level tests; military standard test requirements for space vehicles, laboratory experiments in Fltsatcom Laboratory on satellite performance, in Spacecraft Test Laboratory for vibration, modal and thermal tests; and in Spacecraft Attitude Control Laboratory for spacecraft control performance. PREREQUISITE: Consent of Instructor.

AA3815 INTRODUCTION TO SPACECRAFT DYNAMICS. (3-2).

Coordinate system transformations (GCI, LVLH, etc.), time differentiation operator, velocity and acceleration in 3D-frames of reference, Poisson's equations, spacecraft application examples (strapdown, INS, etc.), angular momentum, inertia tensor transformations, Newton-Euler equations of motion, spin stability, single-spin spacecraft, nutation and precession, energy-sink analysis, passive nutation control, dual-spin concept, gravity-gradient stabilization, Lagrangian dynamics. PREREQUISITES: PH1121, PH2511, MA2121.

AA3818 SPACECRAFT ATTITUDE, DYNAMICS AND CONTROL. (3-2).

Stability of dual-spin stabilized spacecraft, active nutation control, disturbance torques:solar, magnetic, gravity gradient, and aerodynamic, attitude sensors, antenna beam pointing accuracy, three-axis-stabilized spacecraft, fixed momentum wheel with thrusters, three reaction wheel system, attitude control pointing requirements for military spacecraft. PREREQUISITES: EC2300, AA3815.

AA3851 SPACECRAFT PROPULSION. (3-2).

Introduces concepts and devices in spacecraft propulsion. It reviews fundamental fluid mechanics, electricity and magnetism, and thermodynamics with molecular structure. Conventional chemical means such as H₂/O₂ and monopropellants are discussed. Electric propulsion schemes (resistojets, arc-jets, ion, magneto-plasma-dynamic, etc.) are introduced and their performances contrasted with chemical schemes. Characteristics of more advanced concepts (laser, solar, nuclear, etc.) are also considered. PREREQUISITES: None.

AA3852 PROPULSION FOR LAUNCH VEHICLES. (4-0).

Introduction to propulsion for launch vehicles, beginning with mission energy requirements and an overview of current and proposed launch propulsion devices. Performance analysis, operating characteristics and propellant selection criteria are considered for airbreathing and solid, liquid and nuclear rocket motor propulsion systems. PREREQUISITES: AE2042, AE2043.

AA3900 SPECIAL TOPICS IN AERONAUTICS. (V-0).

Directed graduate study or laboratory research. Course may be repeated for additional credit if topic changes. PREREQUISITE: Consent of Department

Chairman.

AA4000 AERONAUTICAL ENGINEERING SEMINAR. (1-0).

Oral presentations on subjects not covered in formal courses, which treat a wide spectrum of topics ranging from reports of current research to survey treatments of Navy issues and problems of scientific and engineering interest.

AA4103 MECHANICS OF COMPOSITE MATERIALS. (3-2).

A course covering the mechanics of multi-phased composite materials. Prediction of composite properties from the constituent fiber/matrix properties. Design of composite structural components including laminates and sandwich construction. Fabrication and manufacturing techniques for aircraft, missiles and ship structures. Survey of strength theory, damage and repair. PREREQUISITE: AA2021 or ME3611.

AA4201 RELIABILITY ENGINEERING AND SYSTEM SAFETY MANAGEMENT. (4-0).

An introduction to System Safety based on the foundations of statistical sampling and probability modeling with applications to military standard requirements. Mathematical foundations (probability, set theory, Boolean algebra, distribution functions); reliability testing (experimental planning via Monte Carlo simulations, parameter estimation); safety analysis (hazard analysis, fault-tree analysis, monolithic and redundant components) safety criteria and life cycle considerations. Application to aircraft maintenance, repair and retirement strategies.

AA4202 RELIABILITY OF COMPOSITE MATERIALS. (3-2).

A course covering the reliability engineering of composite materials in critical structures in aircraft, missile and space applications. Probability modeling of strength of composites, prediction of geometric size effect, development of standards for specification and acceptance. Reliability assurance methodology, proof-test, life predictions. Structure reliability under combined state of stress, damage repair and inspections. PREREQUISITES: AA4201.

AA4273 AIRCRAFT DESIGN. (3-2).

Conceptual military and/or military related aircraft design methodology utilization and application centers around a student design team project focused on a military need defined by a Request-for-Proposal. Performance, cost, supportability, deployment, manufacturing, product quality and environmental considerations are all included in the design process. The project draws on all of the aeronautical disciplines and provides students with experience in the application of the aerospace disciplines to military aircraft design. PREREQUISITE: Completion of the Aero Graduate Core.

AA4276 AVIONICS SYSTEM DESIGN. (3-2).

This course will take students through each stage involved in the design, modelling and testing of a core avionics systems, i.e., guidance, navigation and control (GNC) systems. Students will be asked to choose an airplane, model its dynamics on a nonlinear simulation package such as SIMULINK and then design a GNC system for this airplane. The complete design is to be tested on SIMULINK. Course notes and labs will cover all the relevant material. PREREQUISITES: AA3276, AA4341.

AA4278 AERODYNAMIC DESIGN. (3-2).

This course introduces the student to the current methods used for the aerodynamic design of aircraft, missiles and helicopters (panel methods, boundary layer methods, Euler and Navier-Stokes codes) and applies these methods to the aerodynamic design of a typical military high-performance flight vehicle. PREREQUISITES: AA2035 AND AA3501.

AA4304 HELICOPTER DYNAMICS AND AERODYNAMICS. (3-2).

This course is especially important to students who will later be involved in helicopter flight testing or helicopter design. Rotorcraft general equations of motion. Rotor blade forces and motions in hover and forward flight. Derivation of trim equations and stability derivatives. Rotorcraft static and dynamic stability requirements. State space and frequency response methods of analysis. Control response. Helicopter flight simulation using real-time "FLIGHTLAB" code. Design of helicopter to meet military flying quality requirements as set forth in MIL-H-8501 and ADS-33 specifications.

PREREQUISITES: AA2015 and AA3402.

AA4305 V/STOL AIRCRAFT TECHNOLOGY. (3-2).

Types of V/STOL aircraft, fundamental principles, main performance characteristics, and propulsion requirements; STOL technology: mechanical and powered high-lift devices, jet flaps, augmentor wings; VTOL technology: flow vectoring devices, lift engine and lift fan technology, airframe/propulsion system interactions, ground interference effects; review of past and current military V/STOL aircraft, programs.

PREREQUISITES: Preparatory Core.

AA4306 HELICOPTER DESIGN. (3-2).

Capstone course in helicopter design where students complete preliminary design of helicopter to meet mission and military specification requirements. Course conducted as part of national AHS/Industry competition. Begin with vehicle design trade-off selection to meet speed, range, maneuver, and air transportability requirements. Rotor design for solidity, aerodynamic, autorotation, and blade dynamics. Includes design for physical parameters, aircraft structure, armament/weapons system, cockpit cooling, engine and drive train system, weights and balance, performance, handling qualities, combat survivability, safety and crashworthiness, maintainability, and determination of production and direct operating costs. PREREQUISITE: A4304.

AA4318 AEROELASTICITY. (4-0).

Indicial and oscillatory aerodynamics for subsonic and supersonic flight vehicles (aircraft, missiles, helicopters). Static aeroelasticity. Flutter and dynamic response phenomena and prediction methods, buffet and stall flutter. Applications to military flight vehicles PREREQUISITE: AA3340.

AA4323 FLIGHT TEST ENGINEERING (3-2).

Methods for pitot-static calibration, cruise and climb performance, stall testing, longitudinal static and dynamic stability, maneuvering stability, lateral-directional stability, and transonic flying qualities, are treated. An introduction to parameter-estimation methods is presented with military aircraft as examples. PREREQUISITES: AA2036, AA3340.

AA4341 CONTROL OF AEROSPACE VEHICLES. (3-2).

This course will introduce students to basic concepts of linear systems such as controllability, observability, detectability and stabilizability. The course will then present the fundamentals of realization theory and will go on to discuss internal and input/output stability of linear systems. The course will also investigate the effect of white noise excitation on aerospace vehicles through covariance analysis based on Lyapunov equation. The course will then proceed to introduce the Linear Quadratic Regulator and Kalman Filtering Theory. All the concepts in the course will be done for both continuous and discrete-time systems. Relevant military examples will be presented at each step of the material developed. PREREQUISITES: AA2339, AA3340.

AA4342 ADVANCED CONTROL FOR AEROSPACE SYSTEMS. (3-2).

This course is a continuation of AA 4341. Here the students will be introduced to more recent developments in control theory. First, the course will concentrate on the analysis of the feedback systems. Such ideas as induced norms, small gain theorem, Kharitonov Theorem and structured singular value as well as Bode gain-phase relationship will be introduced. The course will then proceed to discuss the recently developed H_∞ synthesis technique. Applications of these techniques to the design and analysis of fighter and missile control systems will be presented. Whenever possible, the development will be done for both continuous and discrete-time systems.

PREREQUISITE: AA4341.

AA4431 TURBOMACHINES: ANALYSIS, DESIGN & EXPERIMENT. (3-2).

The underlying principles governing flow through and energy exchange in turbomachines are developed to provide a basis for understanding both design and advanced computational methods. Key considerations and procedures followed in the design of new aircraft engine fans are introduced. Lectures are coordinated with experimental test experience at the Turbopropulsion Laboratory. **PREREQUISITE:** AA2043.

AA4451 AIRCRAFT ENGINE DESIGN. (3-2).

The conceptual design of military or military related airbreathing engines is emphasized within student design teams. The design effort is focused in a team response to a Request-for-Proposal (RFP) for an airbreathing engine meeting specified requirements. Performance, cost, supportability, deployment, manufacturing, product quality and environmental considerations are all included in the design process. The project activity draws on all of the aeronautical disciplines and provides students with experience in the integration and application of these disciplines to military airbreathing engine design. **PREREQUISITE:** Completion of the Aero Graduate Core.

AA4452 TACTICAL MISSILE PROPULSION. (4-0).

Applications and analysis of solid propellant rockets, ramjets, dual-combustion ramjets, scramjets and ducted rockets. Propellant selection criteria and characteristics, combustion models and behavior, performance analysis, combustor design, combustion instabilities and damping, mission and flight envelope effects on design requirements and technology requirements. Use of performance and grain design codes (SPP & PEP) and laboratory test firings for comparison with measured performance of rockets and ramjets. Introduction to insensitive munitions and plume signature considerations. Use of NATO/AGARD performance calculation and plume classification methods.

PREREQUISITES: AA2042 OR PH 2724, AA2043.

AA4502 HIGH-SPEED AERODYNAMICS. (4-0).

Transonic, vortex lift, and unsteady aerodynamics. Elements of hypersonic flow, area rule, supercritical airfoils, plus other topics of current military research importance. Numerical techniques as well as perturbation methods of solution. PREREQUISITE: AA3501.

AA4503 MISSILE AERODYNAMICS. (4-0).

The aerodynamics of missiles and guided projectiles for various speed regimes and motions. Topics include slender body and linearized theory as well as nonlinear aerodynamic effects, coupling effects, Magnus effects, etc. The impact of these effects on missile flight dynamics, guidance and control is included. Specific applications are provided with respect to air-to-air, air-to-surface and surface-to-air missiles. PREREQUISITE: AA3501.

AA4504 CONVECTIVE HEAT AND MASS TRANSFER. (4-0).

Convective heat and mass transfer in laminar and turbulent flows. Analytic techniques, integral and numerical methods, experimental correlations. Effects of variations in thermophysical properties. PREREQUISITE: AE3501.

AA4505 LASER/PARTICLE BEAM TECHNOLOGIES. (3-2).

Elements of lasers and particle beams are presented together with a survey of their technologies. High energy lasers, including electrical, gas dynamic, excimer and chemical lasers, are typically treated. Concepts in beam management, propagation and damage mechanisms are discussed. Current military applications and future trends are covered as special topics.

PREREQUISITES: Aero Preparatory Phase or equivalent.

AA4506 RAREFIED GAS DYNAMICS. (4-0).

Topics include advanced thermodynamics with molecular structure, kinetic theory, distribution functions, Boltzmann equation and transport phenomena from a kinetic theory point of view. Types of flow range from free-molecule to transition, to high temperature continuum. Numerical approaches are discussed. Applications to space problems and hypersonics are treated.

PREREQUISITES: Aero Preparatory Phase or equivalent.

AA4507 COMPUTATIONAL FLUID DYNAMICS AND HEAT TRANSFER (3-2).

The emphasis will be on the numerical solution of sets, of partial differential equations, that describe fluid flow and heat transfer. The governing equations for fluid dynamics are reviewed and turbulence modelling is introduced.

Discretization techniques are applied to selected model equations and numerical methods are developed for inviscid and viscous, compressible and incompressible flows. Individual term projects include application of CFD to thesis research and to current military flight and propulsion problems.

PREREQUISITE: MA3232.

AA4641 DIGITAL AVIONICS SYSTEMS. (3-2).

A design-project-oriented course utilizing microprocessor technology with emphasis upon aeronautical engineering applications. Both software and hardware aspects of system integration will be considered for engineering tradeoffs during problem definition and solution. PREREQUISITE: EC2170 or equivalent.

AA4650 PARALLEL DISTRIBUTED PROCESSING (NEURAL NETWORKS)(4-0).

The application of neural networks to current military problems will be emphasized. Problems include targeting based on ISAR images, radar signals, sonar signals and reconfiguration algorithms for damaged military aircraft.

AA4703 MISSILE FLIGHT ANALYSIS. (4-1).

Static and dynamic stability and control. Transient modes. Configuration determinants. Subsonic, transonic, supersonic force and moment data for performance calculations with short and long-range cruciform missiles and cruise missiles: acceleration, climb, ceiling, range and agility in maneuvering trajectories. PREREQUISITE: AA3701

AA4704 MISSILE DESIGN. (3-2).

Conceptual missile design methodology centered around a student design team project, focused on a military need defined by a Request-for-Proposal. It stresses the application of all of the aeronautical disciplines, including aerodynamics, propulsion, flight mechanics, cost, supportability, stability and control and provides the student with their application to design. Consideration is given to trade-offs among propulsion requirements, air loads, quality sensors, guidance laws, quality, controls and structural components. PREREQUISITES: AA3701, AA4452 and AA4703

AA4816 DYNAMICS OF FLEXIBLE SPACE STRUCTURES (4-0).

Finite element analysis, stiffness, mass, and forced response analysis, usage of general purpose finite element computer programs, linear optimal control, controllability and observability, and adaptive structures. PREREQUISITES: EC2300, AA2820, AA3815

AA4830 SPACECRAFT SYSTEMS I (Intended for curriculum 366) (3-2).

This course emphasizes the systems analysis of geosynchronous spacecraft and covers the analysis of GNC (orbit and attitude control), structures, propulsion, thermal and electrical power subsystems. Basic mathematical equations will be used in the preliminary design of the subsystems and the tradeoff studies involved. The differences and similarities between dual-spin and three-axis stabilized spacecraft will be covered in detail. Systems aspect of a typical mission profile will be illustrated. Throughout, emphasis will be on the spacecraft bus. Students will be engaged in problem solving during most of the laboratory period. PREREQUISITES: Completion of Space Engineering core-curriculum

AA4831 SPACECRAFT SYSTEMS II (Intended for curriculum 366). (3-2).

In this course, students will be involved in a group project to design a spacecraft to meet mission requirements. Material presented in AA 4830 as well as AA 4831 will be utilized. In parallel, this course covers some or all of the following aspects of spacecraft systems: spacecraft testing, TT&C subsystem, and design of observation payloads. Differences and similarities between geosynchronous spacecraft and LEO/HEO spacecraft will be discussed. Topics include gravitational perturbation (J2 effects), gravity-gradient stabilization and atmospheric drag effects. PREREQUISITE: AA4830

AA4844 HYPERSONIC FLIGHT (4-0).

Trajectories and characteristic features of flow over re-entry and hypersonic flight vehicles. Effects of Mach number, high enthalpy and low density. Analysis and computational methods for blunt and slender bodies, and for practical vehicle shapes. Ground simulation of re-entry and sustained flight environments. Waverider aircraft and missiles. The hypersonic airbreathing SSTD vehicle and potential military derivatives. PREREQUISITES: AA2035 or consent of instructor, AA2043

AA4850 SPACECRAFT PERFORMANCE AND OPTIMIZATION (3-2).

This course develops basic measures of performance of a space vehicle (including launch vehicles) with methods to target a set of conditions and optimize the performance. Topics include an overview of the Guidance, Navigation and Control System, state-space formulation, vehicle and environmental models, performance measures, problem of Bolza, Maximum Principle, Hamiltonian and transversality conditions, the Moon-Landing problem, Bi-linear tangent law, aerobraking and aerocapture. Where appropriate, the course will illustrate systems aspects of mission design. PREREQUISITES: PH2514, PH2511, AA3815, AA3851.

AA4870 SPACECRAFT DESIGN AND INTEGRATION. (4-0).

Principles of spacecraft design considerations, spacecraft configurations, design of spacecraft subsystems, interdependency of designs of spacecraft subsystems, launch vehicles, mass power estimation, and trade-offs between performance, cost, and reliability. The emphasis is on military geosynchronous communications satellites. The course includes individual design project. PREREQUISITES: AA2820, AA3804, AA3851, AA4818, EO3740, PH2511.

AA4871 SPACECRAFT DESIGN AND INTEGRATION II (2-2).

A team project oriented course on design of non-geosynchronous spacecraft system. Provides understanding of the principles of space system design, integration, and system engineering, and their application to an overall spacecraft mission. Considerations are given to cost, performance, and test plan. Several DOD/NASA organizations, such as Naval Research Laboratory and Jet Propulsion Laboratory, provide support in the definition of the mission requirements for the project, spacecraft design, and design reviews. PREREQUISITE: AA4870.

AA4900 ADVANCED STUDY IN AERONAUTICS (V-0).

Directed graduate study or laboratory research. Course may be repeated for additional credit if topic changes. PREREQUISITE: Consent of Department Chairman.

ER2001 INTRODUCTION TO MILITARY ENVIRONMENTAL ENGINEERING (4-0).

Course coverage provides a broad overview of environmental issues as they impact military operations. This coverage is presented in terms of fundamental environmental concepts. Ecosystems are defined in terms of structure and function. Population dynamics are considered in terms of ecosystems impact. Water, air noise and land pollution generation, transport, resource quality, waste disposal and modeling. Environmental economics as well as national and international environmental policy are considered in terms of environmental impact monitoring, assessment, regulations and laws. PREREQUISITE: Engineering or science background or consent of instructor.

AVIATION SAFETY PROGRAMS

David L. Carroll, CAPT, U.S. Navy; Director (1994)*; BBA, University of New Mexico, 1965.

Milton Harold Bank, II, Associate Professor of Aeronautical Engineering and Safety (1971); PhD, Georgia Institute of Technology, 1971.

William O. Chesser, Jr., LCDR, U.S. Navy; Lecturer in Aviation Safety Programs (1994); BS (Biology), Piedmont College, 1980.

Anthony P. Ciavarelli, Jr., Associate Professor of Psychology (1989); Ed.D., University of Southern California, 1988.

Steven F. Dillon, CDR, U.S. Navy; Lecturer in Aviation Safety Programs (1994); MS (Mgmt), Salve Regina University, 1991.

Steven P. Grohsmeyer, LtCol, U.S. Marine Corps; Lecturer in Rotary-Wing Aerodynamics (1991); AeE, Naval Postgraduate School, 1990.

Eric Nels Hallberg, LT, U.S. Navy; Lecturer in Fixed Wing Aerodynamics (1994); MSAE, Naval Postgraduate School, 1994.

Thomas R. Hazard, Maj, U.S. Marine Corps; Lecturer in Aviation Safety Information Management (1992); MSSM, University of Southern California, 1976.

Edward John Kennedy, Senior Lecturer of Aviation Physiology (1972); MD, University of Iowa College of Medicine, 1962.

Truman E. Long, CAPT, MC, U.S. Navy; Senior Lecturer in Aerospace Medicine (1993); MD, Stanford University, 1961.

Michael D. McLaughlin, LCDR, U.S. Navy; Lecturer in Aviation Safety Information Management (1994); BA, U.C. Santa Cruz, 1979.

David Lee Sohn, LCDR, U.S. Navy; Lecturer in Mishap Investigation (1993); MA, Naval War College, 1991.

* The year of joining the Naval Postgraduate School faculty is indicated in parentheses.

AVIATION SAFETY OFFICER COURSE

An Aviation Safety Officer (ASO) course is offered seven times each year on a temporary additional duty basis for those commands needing an Aviation Safety Officer. This course prepares the graduate to assist his or her commanding officer in conducting an aggressive mishap prevention program. When the ASO completes the course he or she will be able to organize and administer a mishap prevention program at the squadron level as defined in OPNAVINST 3750.6.

This twenty-eight instructional-day course consists of approximately 160 classroom and laboratory hours. Subjects addressed include safety programs, risk assessment and mishap prevention techniques, operational aerodynamics and aerostructures, mishap investigation and reporting, psychology, human factors, safety law and aeromedical support.

Prior completion of college-level courses in algebra and physics is highly desirable for the prospective student.

Designated naval aviators and naval flight officers of the Navy and Marine Corps in the rank of Lieutenant, (USN) and Captain, (USMC) and above are eligible to attend. Exceptions must be approved by the Director, Aviation Safety Programs. Details of quota control and class schedules are defined in NPSNOTICE 1520.

Resident Students

Officers regularly enrolled in other curricula of the Naval Postgraduate School may qualify for the Aviation Safety Officer Certificate by completing these required courses: AO2020, AO2030, AO3000, AO3010 and AO3040. Substitutions of equivalent courses taken in other departments for some of these courses may be made upon approval of the Director of Aviation Safety Programs. For example, AO2020 may be replaced by upper division or graduate courses in aeronautical engineering which cover the essential subject matter of the course.

AVIATION SAFETY COMMAND COURSE

An Aviation Safety Command (ASC) course is offered eight times each year on a temporary additional duty basis to commanding officers, executive officers, officers in charge of aviation detachments, officers screened for command and staff officers in the rank of Lieutenant Commander, USN, Major, USMC and above. This course is designed to provide information which will assist commanding officers in conducting an aggressive mishap prevention program and to prepare the graduate for the duties of Senior Member of a Mishap Board.

The course consists of approximately 35 classroom and laboratory hours over five instructional days, addressing subjects including safety programs, safety psychology and human factors, aviation law, aircraft systems, mishap investigation techniques, mishap and incident reports and endorsements and aerospace medicine.

No academic credit is given for this course.

COURSE OFFERINGS

AO2020 AERODYNAMICS FOR AIRCRAFT ACCIDENT PREVENTION AND INVESTIGATION (2-0).

Survey of aerodynamics, performance, stability and control, with emphasis on pre-mishap hazard identification and risk management. Effects of varying designs, configurations, atmospheric conditions, crew techniques and degraded aircraft capabilities on critical areas of operation are discussed and related to current mishap experience. Introduction to current aircraft technology and future design considerations. (Taught in separate rotary-wing and fixed-wing sections).

AO2030 AIRCRAFT STRUCTURAL ANALYSIS (1- 0).

Fundamentals of strength of materials, design criteria, and theories of failure. Buckling. Effects of stress concentrations; fatigue process. Identification of static and fatigue fractures. Introduction to composite materials technology.

AO3000 MANAGEMENT OF ACCIDENT PREVENTION PROGRAMS (2-1).

Management theories and practices with emphasis on planning, leading, organizing and controlling. Automatic data-processing systems and analysis of accident statistics. Organizational effectiveness theory and techniques as applied to Navy safety programs. Systems safety theories and techniques applied to hazard detection, analysis, and elimination. Group dynamics and human behavior. Applied theory exercise in hazard detection survey techniques at selected naval aviation organizations.

AO3010 SAFETY INFORMATION MANAGEMENT (2-1).

Techniques of mishap investigation and reporting. Introduction to causation analysis, including deductive and inductive methods. Witness interviewing techniques. The legal doctrine of Safety Privilege. Organization and administration of investigative boards and commissions. Through case studies, laboratory and field exercises, the course provides practical experience in investigating and reporting simulated aircraft mishaps.

AO3040 SAFETY PSYCHOLOGY/HUMAN FACTORS (2-0).

Applied psychological and physiological principles in aircraft mishap investigation and prevention. A survey of human performance factors in mishap causation. Human factors

related to safe and effective behavior in high performance/high risk environments, covering capabilities and limitations in sensation and perception, knowledge and skill acquisition motivation and emotion, stress and social adjustment, communication and interpersonal skills.

AO3100 MANAGEMENT OF ACCIDENT-PREVENTION PROGRAMS (3-2).

Management theories, practices, communications and controls; automatic data-processing and analysis of accident statistics; legal consideration in safety management; use of systems safety in hazard identification.

AO3120 TECHNOLOGICAL ASPECTS OF ACCIDENT-PREVENTION AND ANALYSIS (3-2).

Topics include case studies of technological design-related aviation mishaps; identification of structural failure modes; computer and simulator methods in aeronautics; safety-related problems of Navy weapons systems evaluation and acquisition.

COMMAND, CONTROL & COMMUNICATIONS (C3) ACADEMIC GROUP

Chairman:

Paul H. Moose, Associate Professor
Code CC, Spanagel Hall
Room 203
(408) 656-2618 (Voice)
DSN 878-2618
(408) 656-2418 (Fax)

Dan Calvin Boger, Professor (1979)*; PhD, University of California at Berkeley, 1979.

Michael A. Cervi, Capt., U.S. Air Force; Instructor (1992); MS, Naval Postgraduate School, 1992.

Kenneth L. Davidson, Professor (1970); PhD, University of Michigan, 1970.

David Gaitros, LtCol, U.S. Air Force, Instructor (1992); MA, AFIT School of Engineering, 1985.

Donald Paul Gaver, Jr., Distinguished Professor (1970); PhD, Princeton University, 1956.

Wayne Philo Hughes, Jr., Adjunct Professor (1979); MS, Naval Postgraduate School, 1964.

Carl Russell Jones, Professor (1965); PhD, Claremont Graduate School, 1965.

William G. Kemple, Assistant Professor (1990); PhD, University of California at Riverside, 1989.

Hershel H. Loomis, Jr., Professor (1981); PhD, Massachusetts Institute of Technology, 1963.

Orin E. Marvel, Chair in Command, Control and Communications (1994); PhD, University of Illinois, 1970.

Paul H. Moose, Chairman and Associate Professor (1980); PhD, University of Washington, 1970.

Gary Porter, Visiting Professor, (1993); MS Naval Postgraduate School, 1980.

Craig Rassmussen, Assistant Professor (1991); PhD, University of Colorado at Denver, 1990.

Michael Shields, LCDR, U.S. Navy; Assistant Professor (1992); PhD, Naval Postgraduate School, 1991.

Timothy J. Shimeall, Assistant Professor (1988); PhD, University of California at Irvine, 1988.

Michael Graham Sovereign, Professor (1970); PhD, Purdue University, 1965.

Donald van Z. Wadsworth, Senior Lecturer (1988), PhD, Massachusetts Institute of Technology, 1958.

* The year of joining the Naval Postgraduate School faculty is indicated in parentheses.

The Command, Control and Communications (C3) Academic Group is an interdisciplinary association of faculty. The C3 Academic Group has responsibility for the academic content of the Joint Command, Control and Communications curriculum and a C3 research program. Thesis topics are approved by the group and the final thesis is approved by the Chairman.

MASTER OF SCIENCE IN SYSTEMS TECHNOLOGY

The degree Master of Science in Systems Technology (Command, Control and Communications) will be awarded at the completion of an interdisciplinary program carried out in accordance with the following degree requirements.

The Master of Science in Systems Technology (Command, Control and Communications) requires a minimum of 45 quarter hours of graduate level work in four different academic disciplines, of which at least 15 hours must represent courses at the 4000 level in at least two of the disciplines. Within the course program there must be a specialization sequence consisting of at least three courses.

In addition to the 45 hours of course credit, an acceptable thesis must be completed.

The program must be approved by the Chairman of the Command, Control and Communications Academic Group.

COURSE OFFERINGS

CC0001 SEMINARS, VIDEOTELECONFERENCES, AND FIELD TRIPS FOR C4I (SYSTEMS STUDENTS)

Seminars (consisting of guest lectures), videoteleconferences, and field trips are scheduled to provide background information on specific Joint C4I systems and activities.

CC0810 THESIS RESEARCH. (0-8).

Every student conducting thesis research will enroll in this course.

CC3000 INTRODUCTION TO COMMAND, CONTROL & COMMUNICATIONS. (4- 0).

Knowledge of current C3 systems and practice is introduced. A basic framework for understanding C3 is provided. case studies are used as well as lessons learned from crises, field exercises and war gaming. PREREQUISITE: Enrollment in the Joint C3 curriculum, OS 2103 concurrently.

CC3101 COMBAT ANALYSIS FOR C3 (4-0).

Introduction to combat modeling and analysis for C3 students. Emphasis is on the use of mathematical models of search and attack on land and sea to help operational and tactical commanders solve wartime problems or improve the effectiveness of their forces. The course is the basis for later study of models of the command and control process, wargaming and simulation, and C3 systems engineering. A required course for the 365 curriculum. PREREQUISITES: NS3252, CC3001, and OS2103 (may be concurrent).

CC3111 C3 MISSION AND ORGANIZATION (4-0).

A survey of command, control and communications organizations within OSD JCS, and the Service headquarters. Execution of National Security Nuclear Policy and planning for joint employment of general purpose forces are discussed. Service combat organization and service tactical C3 systems are covered. Emphasis is on description of existing C3 organizations and systems, with brief historical perspective PREREQUISITE: SECRET clearance.

CC3900 SPECIAL TOPICS IN COMMAND, CONTROL, AND COMMUNICATIONS. (V-0).

Supervised study in selected areas of command, control and communications to meet the needs of individual students. May be repeated for credit if course content changes. PREREQUISITE: Consent of Group Chairman. Graded on Pass/Fail basis only.

CC4004 C3 IN NATO (4-0).

Application of C3 principles to the special problems of NATO. The range of alternatives to improving arms stability in Europe will be explored, including high-tech solutions such as FOFA, low-tech, green⁷ barriers and militia, as well as arms negotiations. C3 planning and evaluation will be covered in application. PREREQUISITES: U.S. citizenship and SECRET clearance; CC4003 or equivalent.

CC4006 ADVANCED C2 ANALYTICAL CONCEPTS (4-0).

The study of the combat organization's C2 in equilibrium and disequilibrium. The use of Petri Nets in understanding equilibrium is emphasized. The role of catastrophe and chaos theory in understanding disequilibrium is covered. PREREQUISITES: CC4003 or equivalent.

CC4101 SYSTEMS ENGINEERING FOR JOINT C4I SYSTEMS. (4-2).

Provide an introduction to systems engineering by performing systems engineering activities, using the tools that a systems engineer uses, analyzing the procedures a systems engineer follows, and performing an actual systems design on a joint C4I system element. The course will use practical examples to explain the fundamental principles, while maximizing the hands-on practical systems design activities. A required course for the 365 curriculum. PREREQUISITES: CC3001, CS3020, and OS3604.

CC4103 C3 SYSTEMS EVALUATION (2-4).

Experiments in determining C3 system effectiveness using war gaming and simulation. Design of experiments. Survey of current C3 systems evaluation techniques. PREREQUISITES: CC4002, OS3603, TOP SECRET clearance with eligibility for SI/SAO. U.S. Citizenship.

CC4200 COMBAT SYSTEMS ENGINEERING. (4-0).

This course examines the generation of combat system requirements and the relationships between operational, financial planning, and technical communities in fielding a combat system that fulfills those requirements. The contribution of the technical disciplines to the statement and solution of decision problems in design, priority setting, and scheduling are explored through the use of currently outstanding issues. PREREQUISITES: Consent of the Instructor, Basic probability and statistics, 4th quarter standing, SECRET Clearance. Graded on a Pass/Fail basis only.

CC4750 MILITARY C4I SYSTEMS AND NETWORKS. (3-1).

By means of case studies of tactical and strategic military C4I systems, student familiarity is developed concerning system aspects such as network architecture, joint and combined interoperability, measures of performance, and vulnerability to ECM. Models and simulations in current use by DoD are used to determine the operational constraints imposed on the commander by system technical parameters, including environmental factors, under both limited objective and major combat scenarios. A required course for the 365 curriculum. PREREQUISITE: EO3503 (may be concurrent) or equivalent, and SECRET/NOFORN clearance.

CC4900 ADVANCED STUDY IN COMMAND CONTROL AND COMMUNICATIONS. (V-0).

Supervised study in selected areas of command, control, and communications to meet the needs of individual students. May be repeated for credit if course content changes. PREREQUISITE: Consent of Group Chairman. Graded on a Pass/Fail basis only.

CC4913 POLICIES AND PROBLEMS IN C3 (4-0).

Study of the fundamental role C3 systems fulfill in operational military situations, including crisis warning and crisis management. Analysis of the changing role of intermediate level headquarters and its impact on C3 system requirement and design. Consideration of the complexities imposed on C3 systems as the force structure becomes more heterogeneous, as in the case of NATO. Case study of selected incidents and systems. Specifically for students in the C3 curriculum. PREREQUISITES: CC4003, TOP SECRET clearance with eligibility for SI/SAO. U.S. Citizenship.

DEPARTMENT OF COMPUTER SCIENCE

Chairman:

Ted Lewis,
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Associate Chairman for Academic Affairs and

Academic Associate
Michael J. Zyda
Code CS/Zk, Spanagel Hall
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Wolfgang Baer, Research Assistant (1994); PhD, University of California at Berkeley, 1972. Physics. Real Word Database Generation and Real World Simulation.

Valdis Berzins, Professor (1986)*; PhD, Massachusetts Institute of Technology, 1979. Software engineering, specification languages, computer-aided design and engineering databases.

John Daley, LCDR, USN; Instructor (1992); MS, Naval Postgraduate School, 1992.

John Falby, Instructor (1991); MS, Naval Postgraduate School, 1986.

David A. Gaitros, Major, USAF; Lecturer and NPS Air Force Liaison Officer, (1985); MS, Air Force Institute of Technology, 1993. Computer science, software engineering, communications and networks, and database management.

Richard W. Hamming, Adjunct Professor (1976); PhD, University of Illinois, 1942. Coding theory, numerical methods and philosophy of science.

David K. Hsiao, Professor (1982); PhD, University of Pennsylvania, 1968. Database systems: multimodel, multilingual and multibackend systems.

Cynthia E. Irvine, Assistant Professor (1994) PhD, Case Western University, 1975. Computer Security, Trusted Systems Methodologies, Operating Systems.

Yutaka Kanayama, Professor (1990); PhD, Tokyo University, 1965. Robotics, artificial intelligence, and mathematical foundation of computer science.

Frank E. Kelbe, LCDR, USN; Instructor (1993); MS, Naval Postgraduate School, 1987, Computer science, object oriented software development.

Ted Lewis, Professor and Chairman. (1993); PhD, Washington State University (1971), Parallel Computing, object-oriented frameworks, and software engineering.

LuQi, Associate Professor (1986); PhD, University of Minnesota, 1986. Software engineering, scientific computing, rapid prototyping and real-time embedded systems.

G.M. Lundy, Associate Professor (1988); PhD, Georgia Institute of Technology, 1988. Data communications, computer networks, formal models of communications protocols.

Robert B. McGhee, Professor (1986); PhD, University of Southern California, 1963. Robotics and artificial intelligence.

David R. Pratt, Assistant Professor (1993); MS, Naval Postgraduate School, 1988. 3D computer graphics, virtual worlds and environments, user interfaces and computer architecture.

Neil C. Rowe, Associate Professor (1983); PhD, Stanford University, 1983. Artificial intelligence: path planning, database interfaces, vision and tutoring.

Timothy J. Shimeall, Assistant Professor (1988); PhD, University of California at Irvine, 1988. Software engineering: testing, fault-tolerance, empirical evaluation techniques.

Man-Tak Shing, Associate Professor (1988); PhD, University of California at San Diego, 1981. Design and analysis of algorithms, computational geometry and robot motion planning, genetic algorithms, real-time system scheduling, rapid prototyping and embedded systems.

Jon Spear, Major, USAF; Lecturer (1988); Air Force Institute of Technology, 1993, Computer engineering, software engineering and artificial intelligence, computer security, network.

Roger Stemp, Adjunct Research Assistant (1991); MS, Naval Postgraduate School, 1983. Computer security, systems analysis and design.

Louis D. Stevens, Adjunct Professor (1984); MS, University of California at Berkeley, 1949. Computer architecture, logic design and software engineering.

Dennis M. Volpano, Assistant Professor (1991); PhD, Oregon Graduate Institute, 1986. Programming language foundations and type theory.

Thomas C. Wu, Associate Professor (1985); PhD, University of California at San Diego, 1983. Multimedia database systems, object-oriented data modeling and programming, and user interface design.

Amr M. Zaky, Assistant Professor (1989); PhD, Ohio State University, 1989. Parallel processing: parallelization tools, architectural support, program mapping and scheduling.

Michael J. Zyda, Professor (1984); DSc, Washington University, 1984. Computer graphics: virtual worlds and visual simulation systems.

* The year of joining the Naval Postgraduate School faculty is indicated in parenthesis.

The Department of Computer Science provides graduate training and education in major areas of computer science. Thus, both basic and advanced graduate courses are offered. Course work and research lead to either the degree of Master of Science or Doctor of Philosophy. The requirements to complete either program are rigorous and are comparable to those of other major universities.

MASTER OF SCIENCE IN COMPUTER SCIENCE

The degree Master of Science in Computer Science is awarded upon the satisfactory completion of a program, approved by the Chairman, Computer Science Department, which satisfies, as a minimum, the following degree requirements:

- a. At least 40 quarter hours of graduate-level work of which at least 12-quarter hours must be at the 4000 level.

- b. Completion of an approved sequence of courses constituting specialization in an area of Computer Science.
- c. Completion of an acceptable thesis in addition to the 40-quarter hours of course work.

DOCTOR OF PHILOSOPHY IN COMPUTER SCIENCE

The Department of Computer Science has a program leading to the degree Doctor of Philosophy. Areas of special strength in the department are artificial intelligence & robotics, computer graphics & visual simulation, software engineering, database & data engineering, and computer systems & architectures. A noteworthy feature is that the candidate's research may be conducted off-campus in the candidate's sponsoring laboratory or unit of the Federal Government. The degree requirements are as outlined under the general school requirements for the doctor's degree.

COMPUTER SCIENCE LABORATORIES

Laboratory Overview

There are currently seven laboratories:

- Computer Science Academic Laboratory
- Artificial Intelligence and Robotic Laboratory
- Computer Systems and Security Laboratory
- Computer Graphics and Video Laboratory
- Microcomputer Systems Laboratory
- Software Engineering Laboratory
- Visual Database and Interface Laboratory

These laboratories are configured in a complex network system with remote file system access and resource sharing facilities. A backbone network also provides a gateway to the Internet.

Computer Science Academic Laboratory

The laboratory provides a general purpose, time-sharing environment for a variety of programming languages and software tools. Approximately half of the client workstations are located within the laboratory for student access while the remaining client workstations are distributed to individual faculty and staff offices.

Artificial Intelligence and Robotic Laboratory

The Artificial Intelligence Laboratory consists of Unix-based, general purpose workstations. They are outfitted with LISP, Prolog and various knowledge-based software tools. The IRIS workstation is the base system for the Autonomous Mobile Robot "Yamabico-11" with an image-grabbing capability color TV camera. This laboratory also supports the research of planning, navigation, dynamics and control of Autonomous Underwater Vehicle sponsored by NAVSEA.

Computer Systems and Security Laboratory

The Computer Systems and Security Laboratory has three distinct sub-laboratories: the Database Systems Lab, the Multimedia DBMS lab and security lab. The Database System Lab has a focus on multi-backend database machines. The multimedia DBMS lab has a focus on utilizing low-cost workstations and PC technology for the intelligent storage and retrieval of multimedia data. The computer security has a focus on a secure heterogeneous, distributed computing environment.

Computer Graphics and Video Laboratory

The Graphics and Video Laboratory consists of several Silicon Graphics, Inc. IRIS workstations used to provide instructional support for the Computer Graphics & Visual Simulation track of the Department of Computer Science and to provide research support for efforts in virtual world and visual simulation system construction. The laboratory is equipped with a variety of video and multimedia support hardware. Research efforts of the laboratory currently revolve around the NPSNET system, a low-cost, workstation-based, 3D visual simulator that utilizes SIMNET databases and networking formats.

Microcomputer Systems Laboratory

The Microcomputer Systems Laboratory is used for instruction in beginning programming with the Department of Defense's standard computer language Ada. The PCs are also used for research and instruction in microprocessor programming, microprocessor architectures, networking and distributed systems. The PCs are networked together to provide access to shared resources such as printers. The laboratory also supports ongoing research on transputer applications to real-time embedded military systems.

Software Engineering Laboratory

The purpose of this laboratory is to provide a state-of-the-art educational environment for graphics-based software development automation. Current work in the laboratory is on rapid prototyping, specification languages and computer-aided software system design, software verification and testing, software safety and computer-aided instruction.

Visual Database and Interface Laboratory

The Visual Database and Interface Laboratory is used for research and instruction in human-computer interfaces for data retrieval systems. The main project in the laboratory is a visual query language for databases project sponsored by the Naval Weapons Station, Concord.

COURSE OFFERING

CSR100 REFRESHER FOR BEGINNING PROGRAMMING (NO CREDIT) (Meets last 6 weeks of quarter).(2-2)

An introduction to computer algorithms, programs and hardware. Using structured programming and stepwise refinement techniques, students receive classroom instruction plus design and test programs in the laboratory. Computer projects of increasing difficulty are assigned. This course is not graded.

CSR101 REFRESHER FOR LABORATORY SYSTEMS (NO CREDIT) (Meets last 6 weeks of quarter).(2-2)

Intended for computer science majors, to provide an introduction to computer science and computing laboratory facilities. Both Unix and the MS-DOS operating systems are introduced from a user perspective, as well as operation of corresponding workstation and personal computer hardware. Each system's user interface, text processing, programming environment, network and communication facilities are surveyed. Students are exposed to basic principles and procedures for productive software and document development through both lecture and hands-on tutorials. Should be taken concurrently with CS0100. Not graded.

CS0001 COLLOQUIUM (NO CREDIT). (0-1).

Distinguished lecturer series. Attendance is required by students in their third through sixth quarters.

CS0102 REVIEW FOR DIRECT INPUT STUDENTS (NO CREDIT) (Meets entire quarter). (2-1).

An individualized course to cover the topics of CS 0100 and CS 0101. The course is open only to first quarter computer science majors who did not take CS 0100 and CS 0101. This course is not graded.

CS0810 THESIS RESEARCH. (0-8).

Every student conducting thesis research will enroll in this course.

CS2920 INTRODUCTORY TOPICS IN COMPUTER SCIENCE. (V-V).

Designed to support introductory subject matter of special interest, dependent upon faculty availability. Topics will typically augment those offered in the basic core courses. This course may be lecture/lab oriented or self-paced, with prerequisites determined by the instructor. Students may repeat this course for credit with a different topic.

CS2970 STRUCTURED PROGRAMMING WITH ADA. (4-1).

An introduction to problem solving and structured programming with Ada, a high-level, block-structured programming language. This course is for non-computer science majors with a deep interest in the subject. Fundamental techniques of problem solving and using Ada to implement the solutions of non-numerical problems are presented. Several programming projects aimed at practicing these techniques are assigned during the course.

CS2971 INTRODUCTION TO OBJECT-ORIENTED PROGRAMING WITH C++. (3-2).

This course is designed as an introductory course to teach students problem solving techniques and the object-oriented programming paradigm with the language C++. The topics covered include problem-solving, object-oriented programming, native types and statements, operators, structures, functions, pointers, object-oriented programming, documentation (design decisions, functionality, class, etc.), encapsulation (class and objects), inheritance (class hierachies), polymorphism, and I/O. Weekly programming or written assignments required. PREREQUISITE: None.

CS2972 OBJECT-ORIENTED PROGRAMMING WITH ADA. (3-2).

This course is designed to teach students problem solving techniques and object oriented programming paradigm with Ada. Topics covered include problem solving, object-oriented programming methodology (encapsulation, inheritance), Ada programming constructs (declarations, statements, control structures, types, procedures, functions, and packages, and I/O). Weekly programming projects aimed at practicing these techniques are assigned during the course. PREREQUISITES: CS2971 or consent of instructor.

CS3010 COMPUTER SYSTEMS PRINCIPLES. (4-0).

Designed to provide computer science majors with a basic understanding of computer systems hardware. The course includes the following topics. Basic computer concepts, number systems and data representation, digital logic and Boolean algebra, storage devices and organization, basic computer organization and control, and instruction formats, addressing modes and the assembler process. No previous background in computer hardware is assumed. PREREQUISITES: None.

CS3020 SOFTWARE ENGINEERING TO GOVERNMENT STANDARDS. (4-1).

This course is designed to provide students who are not necessarily computer science majors with a general knowledge of the process of developing large complex pieces of software, state-of-the-art techniques and tools and where they can be best applied. Topics to be covered are requirements definition, prototyping, object oriented design, software reuse, functonal requirements, modular design, integration, configuration management, anfd testing. A variety of software tools will be discussed during the course. PREREQUISITE: None.

CS3030 COMPUTER ARCHITECTURE AND OPERATING SYSTEMS. (4-0).

This course, designed for non-computer science majors, provides an overview of basic computer hardware concepts and operating systems software. The following topics are covered: basic computer concepts; data representation; elements of computer architecture and operation; processor and process management; multiprogramming; memory management; and file management. Future trends in computer hardware and operating systems will be discussed. PREREQUISITES: CS2971 or consent of instructor.

CS3050 SOFTWARE DEVELOPMENT FOR COMBAT SYSTEMS. (3-2).

This course covers the unique characteristics of software development for

mission-critical embedded computer systems. Students will be introduced to real-time systems issues including analysis, design, process scheduling, operating systems, communications, architecture and fault-tolerance. The DoD Standard 2167A life cycle model will be explored along with analysis, design, programming, and verification methodologies used in developing combat systems software. Students will learn the Ada programming language's real time tasking and inter-process communication techniques and be introduced to tools for prototyping, code reuse, and automatic code generation and documentation. The laboratory experience includes work with software analysis, design and programming tools to build a combat-type software system from requirements analysis through verification. Intended for non-CS majors. PREREQUISITES: CS2970 or consent of instructor.

CS3111 PRINCIPLES OF PROGRAMMING LANGUAGES. (4-0).

This course is an introduction to the design, evaluation and implementation of programming languages. Imperative, functional, logic, and concurrent programming methodologies are investigated, with an emphasis on practical issues. Tradeoffs in choosing different programming languages for a given task are discussed and principles on which an objective assessment of programming language design can be made are presented. PREREQUISITE: CS2971 or consent of instructor.

CS3113 INTRODUCTION TO COMPILER WRITING. (3-2).

This course is intended to explore the basics of modern compiler design and construction techniques. The fundamentals of scanning, parsing and compiler semantics are developed in the framework of modern compiler-compiler and translator-writing systems technology. The laboratory periods will be used to develop a small model compiler/assembler. PREREQUISITE: CS3111 and CS3300 or consent of instructor.

CS3200 COMPUTER ARCHITECTURE. (3-2).

This course examines the organization of computer and processor architectures. Instruction set design alternatives, processor implementation, memory system hierarchy, and I/O systems are the main topics of study. A quantitative approach is taken in which different design alternatives are evaluated and compared through analysis and/or experimentation. The course is accompanied by a set of labs which reinforce and extend the lecture subject matter. PREREQUISITES: CS3010 and either CS2971, or permission of instructor.

CS3300 DATA STRUCTURES. (3-1).

The purpose of this course is to introduce modern techniques for design, analysis, and implementation of data structures. This includes: theoretical material (time and space analysis, abstract data types); current practice (applications to memory management, compiler design, sorting/searching algorithms); programming techniques (formation hiding, packages programming from specifications, testing); programming practice (non-trivial assignments which emphasize pointers, file I/O, recursion, and teamwork). Weekly programming projects are required in this course. PREREQUISITE: CS2971 or consent of instructor.

CS3310 ARTIFICIAL INTELLIGENCE. (4-0).

Survey of topics and methods of Artificial Intelligence. Methods include rule-based systems, heuristic search and exploitation of natural constraints, means-ends analysis, semantic networks, and frames. Emphasis is placed on solving problems that seem to require intelligence rather than attempting to simulate or study natural intelligence. Projects to illustrate basic concepts are assigned. PREREQUISITE: MA0125 or MA0205 or consent of instructor.

CS3320 DATABASE SYSTEMS. (3-1).

This course presents an up-to-date introduction to database systems including database system architectures, data models, query languages, and design of databases.

PREREQUISITE: CS3300 or consent of instructor.

CS3450 OPERATING SYSTEMS. (3-2).

A theoretical and practical treatment of operating concepts. Major course topics include concurrency, Ada tasking, virtual memory including demand paging and segmentation, dynamic linking and loading, file structures and information security. The laboratory portion of the class will give students the opportunity to write and test components of a modern operating system. **PREREQUISITES:** CS2972, CS3200 and CS3300, or consent of instructor.

CS3460 SOFTWARE METHODOLOGY. (3-1).

Introduction to the software life cycle. Methods for requirements definition, design, and testing of software. Basic concepts of software engineering, including stepwise refinement, decomposition, information hiding, debugging, and testing. **PREREQUISITES:** CS2972 and CS3300.

CS3502 COMPUTER COMMUNICATIONS AND NETWORKS. (4-0).

An introduction to the structure and architecture of computer networks. The physical, data link and network layers of the ISO model are covered, as well as some aspects of the higher layers. Several important communication protocols are studied, including the currently used models for their specifications and analysis. Local Area Networks, such as Ethernet and Token Ring, are also covered. Term papers and/or projects are an important aspect of this course. **PREREQUISITES:** CS3200 and CS3010 and a basic course in probability.

CS3601 THEORY OF FORMAL LANGUAGES AND AUTOMATA. (4-0).

This course will cover the Chomsky hierarchy of Formal Languages (regular sets, context-free languages, context-sensitive languages, and recursively enumerable languages) and the types of grammars and automata associated with each class in the hierarchy. Emphasis is placed on the major results of the theory as they apply to language and compiler design. In addition, the major results involving the concept of undecidability are covered.

PREREQUISITES: MA2025 or equivalent.

CS3650 DESIGN AND ANALYSIS OF ALGORITHMS. (4-0).

This course focuses on the design and analysis of efficient algorithms. Techniques for analyzing algorithms in order to measure their efficiency are presented. Control structure abstractions, such as divide and conquer, greedy, dynamic programming, backtrack (branch and bound), and local search methods are studied. The theory of NP-completeness is presented along with current approaches to NP-hard problems. **PREREQUISITES:** CS3300, MA2025 or equivalent.

CS3651 COMPUTABILITY THEORY AND COMPLEXITY. (3-1).

This course covers the concepts needed to argue about the decidability and computational complexity of problems. Topics include recursive enumerability, undecidability, diagonalization, computational complexity classes, intractability, Turing reduction, and many-one reducibility. Basic techniques are presented for proving undecidability and for establishing a lower bound on the computational complexity of a problem. **PREREQUISITES:** CS3601 and CS3650.

CS3700 ADVANCED PROGRAMMING IN C++. (3-2).

This course covers the design and implementation of computer programs in the programming language C++. The implementation part of the course is on

programming including types, operators, structures, control, and functions. The designing part of the course is on object-oriented programming, encapsulation (classes and objects), inheritance (class hierarchies), polymorphism, templates, and reusable class libraries. **PREREQUISITE:** CS2971 and CS3300 or the consent of the instructor.

CS3800 DIRECTED STUDY IN COMPUTER SCIENCES. (0-V).

Individual research and study by the student under the supervision of a member of the faculty. The course is intended primarily to permit interested students to pursue in depth subjects not fully covered in formal class work. **PREREQUISITE:** Consent of Instructor. Graded on Pass/Fail basis only.

CS3920 TOPICS IN COMPUTER SCIENCE. (V-V).

Designed to support subject matter of special interest, dependent upon faculty availability. Topics will either be drawn from areas not covered by core courses, or be focused treatments of subjects of limited scope. This course may be lecture or lab oriented, with prerequisites determined by the instructor. Students may repeat this course for credit with a different topic. **PREREQUISITE:** Consent of instructor.

CS4112 DISTRIBUTED OPERATING SYSTEMS (3-2).

An advanced treatment of operating systems concepts. Major course topics include distributed operating systems, distributed operating system architectures and concurrent programming. Other topics including secure operating systems and real-time operating systems as time permits. **PREREQUISITE:** CS3450 or equivalent.

CS4113 ADVANCED LANGUAGE TOPICS. (4-0).

This course designed to explore concepts considered essential to the study of programming languages. These concepts include the lambda calculus, the Church-Rosser Theorem, reduction strategies, continuations, semantics, and recursion. **PREREQUISITES:** CS3111 and CS3450 or consent of instructor.

CS4114 ADVANCED TOPICS IN OBJECT-ORIENTED PROGRAMMING. (3-2).

This course covers the area of object-oriented programming (OOP) in detail. Investigating current OOP research will be the mainstay of the class. Typical topics will include data abstraction, inheritance, encapsulation, delegation, object-oriented databases and concurrency. Object-oriented languages and applications will also be discussed. A significant programming project is also required. **PREREQUISITE:** CS4113 or consent of instructor.

CS4150 PROGRAMMING TOOLS AND ENVIRONMENTS. (4-1).

This course covers the design and implementation of tools to aid software development, including syntax-directed editors, version-control systems, language-oriented debuggers, symbolic execution vehicles, programming databases, type checkers, macroprocessors and automatic programming tools. These topics are discussed in the context of an integrated, language-oriented programming environment. **PREREQUISITE:** CS3460 or consent of instructor.

CS4202 COMPUTER GRAPHICS. (3-2).

An introduction to the principles of the hardware and the software used in the production of computer generated images. The focus of the course is a major design project utilizing the departmental computer graphics facilities. The course is intended for Computer Science students proficient in the development of software systems. **PREREQUISITE:** CS2971, CS3300, CS3700 or consent of the instructor.

CS4203 INTERACTIVE COMPUTATION SYSTEMS. (3-2).

This course studies the principles of human computer interfaces and their implementation techniques. Several different interfaces are covered with an emphasis

on the direct manipulation interface. The principles discussed in the course will be illustrated with several commercial software systems. The main focus of the course is a design project of building simple application software system that supports human-computer interface principles. PREREQUISITES: CS3111 and CS3300 or consent of instructor.

CS4310 ARTIFICIAL INTELLIGENCE TECHNIQUES FOR MILITARY APPLICATIONS(4-0).

Artificial Intelligence has seen a rapid growth in applications in recent years. This course will survey key areas of current research. Areas surveyed include language understanding, computer vision, planning human tutoring, qualitative reasoning, and automated reasoning. PREREQUISITE: CS3310 or consent of instructor.

CS4311 EXPERT SYSTEMS. (3-2).

This course covers fundamental issues in expert system design and construction. Topics include: knowledge representation schemes and reasoning methods, uncertainty management, truth maintenance trade-off of search versus knowledge by computer induction, real time knowledge based systems, system building tools and shells, and validation and measurements methods. Several projects related to these topics will be assigned throughout the course. In addition, each student will be required to complete a term project. PREREQUISITES: CS3310 (or equivalent) or consent of instructor.

CS4312 ADVANCED DATABASE SYSTEMS. (3-1).

This course is a sequel to CS3320, Database Systems. The course will provide an in-depth coverage of relational database theory, distributed database systems, semantic data models, query processing and optimization, transaction management, recovery, security and other advanced topics. Topics will be illustrated using both commercial and prototype database systems. PREREQUISITE: CS3320 or consent of instructor.

CS4313 ADVANCED ROBOTIC SYSTEMS. (4-0).

This course covers the fundamental concepts, theories and practices in autonomous robotics. Especially, theories and techniques in motion planning, motion design, vehicle kinematics, sensing, guidance, learning, environmental representation, and control architectures for autonomous mobile vehicles will be discussed. The autonomous mobile robot Yamabico-11 will be used for hand-on experiments. We will also discuss on several existing significant robotic research projects and control architectures in the U.S. and other countries. PREREQUISITE: CS3310 or consent of instructor.

CS4314 SYMBOLIC COMPUTING. (3-2).

This course is concerned with symbolic computing, that is, using computers to manipulate symbols. The first part of the course will focus on the fundamentals of Lisp programming including list processing, function definition, recursion, data structures, Common Lisp Object System (CLOS), and Lisp I/O. The second part of the course will emphasize the use of Lisp to support different Artificial Intelligence applications: search techniques, neural networks, genetic algorithms, etc. Students are required to complete several homework exercises and a term project. Enrollment will be limited to ensure adequate student involvement in class presentations. PREREQUISITES: CS3310 or equivalent) or consent of instructor.

CS4322 ADVANCED DATABASE SYSTEMS SEMINAR. (3-1).

This course covers the advanced and current research on database topics that have not been discussed fully in the prior database courses CS3320 and CS4312. Possible topics to be discussed in the course include object-oriented databases, database machines (especially multilingual and multibackend systems), multimedia

DBMS, semantic modeling, DB security, knowledge-based DBMS, nonnormalized relations, temporal information handling, advanced data structures, real-time database systems, etc. The studies may be theoretical, pragmatic and analytical, or experimental using some advanced prototype database systems. PREREQUISITE: CS4312, or consent of instructor.

CS4450 ADVANCED COMPUTER ARCHITECTURE. (4-0).

This course covers advanced topics in computer architecture and the application of concepts in computer architecture to the design and use of computers. The topics discussed include classes of computer architecture, application oriented architecture and high performance architecture.

PREREQUISITES: CS3200 or equivalent.

CS4451 INTRODUCTION TO PARALLEL COMPUTING. (4-1).

An introduction to the basic issues of parallel computing. The course brings the students to acknowledge of different models of current parallel computers, and the interconnection networks that support them. Students are introduced to metrics that describe the performance of parallel computer systems. The students are introduced to a variety of parallel algorithms to put different parallel models into perspective. A major design project utilizing NPS parallel and/or distributed computing facilities is assigned. PREREQUISITES: CS3200 AND ABILITY TO PROGRAM IN C or C++.

CS4452 PROGRAMMING PARALLEL COMPUTERS. (2-4).

A hands-on introduction to parallel computing. The course introduces the student to different scientific and engineering applications that can benefit from parallel computing. The performance trade-offs among different ways of parallelizing an application are discussed. With the aid of parallel programming development tools, the students design, implement, debug, and monitor parallel programs for a few of the applications discussed. Every student is required to complete a nontrivial parallel program for solving some problem pertaining to his/her academic fields of study. The course is intended for CS and non-CS majors.

CS4470 IMAGE SYNTHESIS. (3-2).

This course covers advanced topics in computer image generation. The focus of the course is quality and realism in computer image synthesis. Planned topics include illumination, shading, transparency, antialiasing, shadows, raytracing, texturizing and radiosity. PREREQUISITE: CS4202 and the consent of the instructor.

CS4471 COMPUTER ANIMATION. (3-2).

This course has the goal of presenting the state-of-the-art in animating 3D computer models. We will examine computational techniques for real time animation, motion control systems, interactive keyframe systems, motion simulation, event driven animations, kinematic methods for figure animation, dynamics for figure animation, task-level animations and other high-level approaches to animation. PREREQUISITE: None.

CS4472 PHYSICALLY-BASED MODELLING. (3-2).

A physically-based model is a mathematical representation of an object (or its behavior) which incorporates forces, torques, energies and other attributes of Newtonian physics. The goal of this course is to use such modeling to simulate, and graphically depict, the realistic behavior of flexible and rigid 3D objects. Topics covered in the course include teleological modeling, kinematic constraints, behavior functions, inverse dynamics, collision detection, distributed behavioral models, flexible bodies, energy constraints and physically-based rendering. PREREQUISITES: CS4202 or consent of the instructor.

CS4473 VIRTUAL WORLDS AND SIMULATION SYSTEMS. (3-2).

This course covers the design and implementation of real-time, visual simulation systems for animating and interacting with virtual environments. The course pays special attention to practical issues involving performance/realism tradeoffs; experience with computer/human interaction, especially novel input devices and paradigms; and simulating kinematic and dynamic behaviors in real-time.

COREQUISITE: CS4202 or consent of the instructor.

CS4500 SOFTWARE ENGINEERING. (3-1).

The techniques for the specification, design, testing, maintenance and management of large software systems. Specific topics include software life cycle planning, cost estimation, requirements definition and specification, design, testing and verification, maintenance and reusability. The laboratory sessions will discuss special topics.

PREREQUISITE: CS3460 or consent of instructor.

CS4520 ADVANCED SOFTWARE ENGINEERING. (3-0).

This course is a sequel to CS 4500. The methods for specifying, designing, and verifying software systems are covered in depth, with emphasis on automatable techniques and their mathematical basis. The techniques are applied to construct and check Ada programs using a formal specification language. The course concludes with a summary of current research areas in software engineering. **PREREQUISITE:** CS4500 or consent of instructor.

CS4530 SOFTWARE ENGINEERING WITH ADA. (3-0).

This course is a sequel to CS4500. The study of software engineering in Ada represents a tremendous opportunity for improvement in the clarity, reliability, efficiency, and maintainability of software systems. Special features of designing large, real-time, embedded computer systems, automated tools in the Ada environment, and many applications of the principles in software engineering will be illustrated through the systematic study of the Ada language. **PREREQUISITES:** CS4500 or consent of the instructor.

CS4540 SOFTWARE TESTING. (3-1).

This course covers the theory and practice of testing computer software with the intent of preventing, finding and eliminating bugs in software. Planning and executing software tests are covered, including requirements-based testing, and advanced testing techniques. These topics are discussed in the context of a realistic development environment, illustrated using a variety of software testing tools. **PREREQUISITE:** CS4500 or consent of instructor.

CS4550 COMPUTER NETWORKS II. (4-0).

This course is a continuation of CS3502. The course study emphasizes metropolitan area networks and wide area networks, including the recently developed optical fiber network standards. Integrated networks and ISDN/BISDN are covered. The public telephone network and its relationship to computer networks. Applications of high speed networks. Applications of high speed networks and potential future developments. **PREREQUISITE:** CS3502.

CS4601 COMPUTER SECURITY. (4-0).

This course is concerned with fundamental principles of computer security. It covers privacy concerns, secrecy issues, operational security, physical security, hardware security, software security, communications security, and data security. There is a special emphasis on multilevel security and access control in computer systems. **PREREQUISITES:** For CS majors, CS3200, CS3320, CS3450, CS3460 and CS3502; for CSM majors, CS3010, CS3020, CS3030, CS3220 and IS3502.

CS4602 ADVANCED COMPUTER SECURITY. (4-0).

This course focuses on applied computer security technology developed over the last fifteen to twenty years. Specific topics include a review of finite state machines, finite state security models, implementation of multilevel security mechanisms, architectural considerations, formal specification and verification, multilevel databases, networks and distributed systems in a multilevel environment. The course will also take an in depth look at recent advances in encryption services, integration of encryption into packet protocols and key management. The the basic text for the course will be augmented by several papers dealing with recent research in various technical areas. In addition to several homework assignments, each student will be required to do a major paper or project. PREREQUISITE: CS4601 or consent of instructor.

CS4800 DIRECTED STUDY IN ADVANCED COMPUTER SCIENCE. (0-V).

Directed advanced study in computer science on a subject of mutual interest to student and faculty member. Intended primarily to permit students to pursue in-depth subjects not fully covered in formal class work or thesis research. May be repeated for credit with a different topic. PREREQUISITE: Consent of instructor. Graded on Pass/Fail basis only.

CS4900 RESEARCH SEMINAR IN COMPUTER SCIENCE. (0-2).

This course will examine the current and planned research of Computer Science faculty and Ph. D. students in multiple fields of study. The course is designed to support Computer Science students in their fourth quarter of study in the selection of an area/ topic for thesis research. PREREQUISITE: Computer Science students in fourth quarter or consent of Department Chairman. Graded Pass/Fail basis only.

CS4910 ADVANCED READINGS IN COMPUTER SCIENCE. (0-V).

Directed readings in computer science on a subject of mutual interest to student and faculty member. The course allows in-depth study of advanced topics not fully covered in formal class work or thesis research. May be repeated for credit with a different topic. PREREQUISITE: Consent of instructor.

CS4920 ADVANCED TOPICS IN COMPUTER SCIENCE. (V-V).

Designed to support advanced subject matter of special interest, dependent upon faculty availability. Topics will be drawn from areas not covered by other advanced courses, or be focused treatments of subjects of limited scope. This course may be lecture or lab oriented, with prerequisites determined by the instructor. Students may repeat this course for credit with a different topic.

DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

Chairman:

Michael A. Morgan
Professor
Code EC, Spanagel Hall
Room 437
(408) 656-2081
DSN 878-2081

Richard W. Adler, Senior Lecturer (1970)*; PhD,
Pennsylvania State University, 1970.

Robert W. Ashton, Assistant Professor (1992); PhD,
Worcester Polytechnic Institute, 1991.

Raymond Bernstein, Visiting Instructor (1989); MS,
Naval Postgraduate School, 1982.

Associate Chairmen:

Instruction

Charles W. Therrien
Professor
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Room 458
(408) 656-3347
DSN 878-3347

Randy Borchardt, Visiting Instructor (1992); MSEE
and EE, Naval Postgraduate School, 1988.

Jon T. Butler, Professor (1987); PhD, Ohio State
University, 1973.

John G. Ciezki, Assistant Professor (1994); PhD,
Purdue University, 1993.

Roberto Cristi, Associate Professor (1985); PhD,
University of Massachusetts, 1983.

Student Programs

R. Clark Robertson
Associate Professor
Code EC/Rc, Spanagel Hall
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Monique P. Farques, Assistant Professor (1989);
PhD, Virginia Polytechnic Institute and State
University, 1988.

Douglas J. Fouts, Assistant Professor (1990); PhD,
University of California at Santa Barbara, 1990.

Research

Herschel H. Loomis, Jr.
Professor
Code EC/Lm, Spanagel Hall
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Gurnam S. Gill, Visiting Associate Professor (1990);
PhD, Southern Methodist University, 1981.

Tri T. Ha, Professor (1987); PhD, University of
Maryland, 1977.

Ralph Hippenstiel, Associate Professor (1986); PhD,
New Mexico State University, 1985.

Robert (Gary) Hutchins, Associate Professor (1993);
PhD, University of California at San Diego, 1988.

Ramakrishna Janaswamy, Associate Professor
(1987); PhD, University of Massachusetts, 1986.

David C. Jenn, Associate Professor (1990); PhD,
University of Southern California, 1989.

Jeffrey B. Knorr, Professor (1970); PhD, Cornell
University, 1970.

Allan Kraus, Senior Lecturer (1976); PhD, University
of South Florida, 1976.

Alex W. Lam, Associate Professor (1990); PhD,
University of Illinois, 1987.

Jovan E. Lebaric, Visiting Associate Professor (1993);
PhD, University of Mississippi, 1987.

- Chin-Hwa Lee**, Professor (1982); PhD, University of California at Santa Barbara, 1975.
- Hung-Mou Lee**, Associate Professor (1982); PhD, Harvard University, 1981.
- Frederic H. Levien**, Senior Lecturer (1990); MS, Lehigh University, 1967.
- Herschel H. Loomis, Jr.**, Professor (1981); PhD, Massachusetts Institute of Technology, 1963.
- Ken MacDonald**, LCDR, U.S. Navy; Instructor (1993); MSEE, Naval Postgraduate School, 1987.
- Robert B. McGhee**, Professor (1986); PhD, University of Southern California, 1963.
- Sherif Michael**, Associate Professor (1983); PhD, University of West Virginia, 1983.
- James H. Miller**, Associate Professor (1987); ScD, Massachusetts Institute of Technology and Woods Hole Oceanographic Institution, 1987.
- Paul H. Moose**, Associate Professor (1980); PhD, University of Washington, 1970.
- Michael A. Morgan**, Professor (1979); PhD, University of California at Berkeley, 1976.
- Phillip E. Pace**, Assistant Professor (1992); PhD, University of Cincinnati, 1990.
- Rudolph Panholzer**, Professor (1964); DSc, Technische Hochschule in Graz, Austria, 1961.
- Ron J. Pieper**, Associate Professor (1990); PhD, University of Iowa, 1984.
- John P. Powers**, Professor (1970); PhD, University of California at Santa Barbara, 1970.
- R. Clark Robertson**, Associate Professor (1989); PhD, University of Texas at Austin, 1983.
- D. Curtis Schleher**, Professor (1994); PhD, Polytechnic University, 1975.
- Michael Shields**, LCDR, U.S. Navy; Assistant Professor (1992); PhD, Naval Postgraduate School, 1991.
- Shridhar, B. Shukla**, Assistant Professor (1990); PhD, North Carolina State University, 1989.
- Rasler W. Smith**, Visiting Instructor (1994); MSEE and EE, Naval Postgraduate School, 1990.
- Robert D. Strum**, Professor Emeritus (1958); MS, University of Santa Clara, 1964.
- Frederick Terman**, Visiting Associate Professor (1983); MSEE, Stanford University, 1964.
- George J. Thaler**, Professor Emeritus (1951); DEng, Johns Hopkins University, 1947.
- Charles W. Therrien**, Professor (1984); PhD, Massachusetts Institute of Technology, 1969.
- Harold A. Titus**, Professor (1962); PhD, Stanford University, 1962.
- Murali Tummala**, Associate Professor (1987); PhD, India Institute of Technology, 1984.
- Donald van Z. Wadsworth**, Senior Lecturer (1988); PhD, Massachusetts Institute of Technology, 1958.

Xiaoping Yun, Associate Professor (1994); ScD, Washington University, 1987.

Lawrence J. Ziomek, Associate Professor (1982); PhD, Pennsylvania State University, 1981.

* The year of joining the Naval Postgraduate School faculty is indicated in parentheses.

The Department of Electrical and Computer Engineering is the major contributor to programs for the education of officers in the Electronic Systems Engineering curriculum and the Space Systems Engineering curriculum. Additionally, the department offers courses in support of other curricula such as Electronic Warfare Systems Technology, Information Technology Management, Command, Control and Communications, Space Systems Operations, Weapons Systems Engineering, Underwater Acoustics and Engineering Acoustics.

The department offers programs leading to the Master of Science degree in Electrical Engineering (MSEE), the degree of Electrical Engineer (EE) and Doctor of Philosophy (Ph.D.). The department typically graduates over 100 MSEE degree candidates, five EE degree recipients and one Ph.D. per year.

An MSEE student will usually spend six to twelve months learning or reviewing material at a junior or senior level before entering into graduate studies. The graduate study portion of a typical program is about one year in duration with a combination of course study and thesis work being performed. The thesis portion of the study is the equivalent of four courses with an acceptable written thesis being a requirement for graduation.

The curriculum is organized to provide the students with coursework spanning the breadth of Electrical and Computer Engineering. In addition, students concentrate in one major area of Electrical and Computer Engineering by taking a planned sequence of advanced courses. Currently there are formal concentrations in:

- Communications Systems
- Computer Systems
- Guidance, Navigation and Control Systems
- Electromagnetic Systems
- Power Systems
- Signal Processing Systems

The program leading to the MSEE is accredited as an Electrical Engineering Program at the advanced level by the Engineering Accreditation Commission of the Accreditation Board for Engineering and Technology.

The department has about forty-five faculty members either on a permanent or visiting basis contributing to the instructional and research programs.

MASTER OF SCIENCE IN ELECTRICAL ENGINEERING

A Bachelor of Science in Electrical Engineering or its equivalent is required. Credits earned at the Naval Postgraduate School and credits from the validation of appropriate courses at other institutions are combined to achieve the degree equivalence.

To complete the course requirements for the master's degree, a student needs a minimum of 52 credit hours of graduate level work. There must be a minimum of 36 credits in the course sequence 3000 - 4999 of which at least 24 credits must be in Electrical and Computer Engineering and at least 3 must be in mathematics. The remainder of these 36 credits must be in engineering, mathematics, physical science, and/or computer science. Specific courses may be required by the department and at least four courses that total a minimum of 12 credits, must be in the course sequence 4000 - 4999.

An acceptable thesis for a minimum of 16 credits must be presented to, and approved by, the department.

MASTER OF SCIENCE IN ENGINEERING SCIENCE

Students with acceptable academic backgrounds may enter a program leading to the degree Master of Science in Engineering Science. The program of each student seeking this degree must contain at least 52 credit hours of graduate level work including 36 credit hours in the course sequence 3000 - 4000. Of these 36 course credits, at least 20 must be in Electrical and Computer Engineering, and an additional 12 must be in engineering, mathematics, physical science and/or computer science. At least 12 of the 36 must be in the course sequence 4000-4999. All students must submit an acceptable thesis of at least 16 credit hours. This program provides depth and diversity through specially arranged course sequences to meet the needs of the Navy and the interests of the individual. The department Chairman's approval is required for all programs leading to this degree.

ELECTRICAL ENGINEER

Students with strong academic backgrounds may enter a program leading to the degree Electrical Engineer.

A minimum of 96 total graduate credits is required for the award of the engineer's degree of which at least 24 must be in accepted thesis research and at least 54 credits must be in Electrical and Computer Engineering courses.

At least 36 of the total hours are to be in courses in the sequence 4000 - 4999. Approval of all programs must be obtained from the Chairman, Department of Electrical and Computer Engineering.

DOCTOR OF PHILOSOPHY

The Department of Electrical and Computer Engineering has an active program leading to the degree Doctor of Philosophy. Joint programs with other departments are possible. A noteworthy feature of these programs is that the student's research may be conducted away from the Naval Postgraduate School in a cooperating laboratory or other installation of the Federal Government. The degree requirements are as outlined under the general school requirements for the doctor's degree.

LABORATORIES

The laboratories of the department serve the dual role of supporting the instructional and research activities of the department. The department has well-developed laboratories in each specialty area.

The Controls Laboratory is primarily an instructional laboratory, supporting experiments in simulation and in hardware manipulation. The Circuits/Electronics Laboratory is also an instructional laboratory supporting courses in circuit analysis and design as well as electronic devices and applications.

The Digital Signal Processing Laboratory is primarily for research and thesis work. The laboratory provides a special subnetwork of SUN workstations, some of which are equipped for advanced digital, audio and image processing. A set of smaller microcomputers to support instruction in digital signal and image processing is available elsewhere in the department.

The Digital Systems Laboratory supports both instruction and research. The laboratory is equipped with microprocessor development systems including an HP64000 for advanced course work and thesis research. CAD facilities are capable of schematic capture, circuit simulation and fault detection. Major systems in the Computer Laboratory include a modem distributed server system with a number of intelligent workstations with interactive color graphics and image processing systems. A department-wide Ethernet system provides resource-sharing and integrates these systems with office and laboratory microcomputers.

The VLSI Laboratory supports work in system design using integrated circuits and design of custom integrated circuits. Color graphic displays are used for layout of N-channel MOS (Metal-Oxide-Semiconductor) (NMOS) and Complementary MOS (CMOS) circuits.

The Optical Electronics Laboratory supports both research and courses in the areas of optics that use electronics. The laboratory has low and medium power lasers including CO lasers, an argon ion laser, a dye laser, a Nd:YAG laser and a variety of HeNe and diode lasers. A variety of detectors and imaging equipment is also available.

The Radar and EW Laboratories support courses and thesis work. Working radar systems and EW systems have been modified to allow student access to the signal processing portions of the equipment.

The Academic Computing Laboratories provide the latest SUN distributed system with three servers, 24 workstations, and 24 high-power personal computers for student use.

The Microwave Laboratory provides materials, devices, components, instrumentation, computer software and systems support instructional activities and research in the frequency range from 100 MHz to 300 GHz. A high quality anechoic chamber with HP8510C Network Analyzer is available for broad band antenna pattern and impedance measurements.

The Transient Electromagnetics Scattering Laboratory supports research related to impulse antenna design and impulse radar target classification.

The Power Systems Laboratory supports research and instruction in all aspects of electric power generation, distribution and utilization for ships, submarines and other military systems.

Other support facilities within the department include the Calibration and Instrument Repair Laboratory and the Supply and Issue Facility for the ordering of instrumentation and electronic components.

COURSE OFFERINGS

EC0810 THESIS RESEARCH (0-8).

Every student conducting thesis research will enroll in this course.

EC0950 SEMINAR (NO CREDIT) (0-1).

Lectures on subjects of current interest will be presented by invited guests from other universities, government laboratories, and from industry, as well as by faculty members of the Naval Postgraduate School.

EC1010 INTRODUCTION TO MATLAB (1-1).

An introductory course for students with little or no programming background using MATLAB. Basic concepts of the MATLAB environment are considered such as matrix operations, vector and matrix manipulations, equation solving, simulation, programming, and graphing. This course will prepare students for using Matlab in future course work in the ECE department.

EC2010 PROBABILISTIC ANALYSIS OF SIGNALS AND SYSTEMS (3-1).

The foundations of signals and systems are developed from probabilistic and statistical approaches. Emphasis is on signal processing, communication systems, and computer networks relevant to military applications. Topics include probability, random variables, and random sequences; density and distribution functions; deterministic versus nondeterministic signals; expectation, the dc and the r.m.s. values of nondeterministic signals, correlation and covariance; radar and sonar signal detection; LTI systems, transformation of random variables and the central limit theorem; basic queuing theory and computer communication networks. **PREREQUISITE:** EC2410 (may be concurrent).

EC2100 CIRCUIT ANALYSIS (3-2).

The fundamental circuit analysis course for Electrical Engineering majors. The course considers principles, circuit topology, direct current circuits, natural response, forced response, total response, steady-state ac circuits, ac power, frequency response and selectivity, the Laplace transformation, two-port networks and transformers.

PREREQUISITES: PH1332, MA1043 and MA1117 (may be concurrent).

EC2170 ELECTRICAL ENGINEERING FUNDAMENTALS (4-2).

An introductory course for non-electrical engineering majors. The course considers network principles, signal processing circuits, natural response, forced response, total response, steady-state ac circuits, ac power, frequency selectivity, principles of magnetism, magnetic circuits and transformers. PREREQUISITES: PH1111, PH1121, MA1118 or consent of instructor.

EC2200 ELECTRONICS ENGINEERING I (3-3).

This course provides an introduction to electronic devices and circuits. Topics include solid state physics and semiconductor fundamentals; properties of p-n junctions in diodes; Bipolar Junction Transistors (BJT) and Field Effect Transistors (FET); static and dynamic models for these devices, and their linear and nonlinear applications; applications of transistors in the design of amplifiers and digital systems; ideal operational amplifier characteristics and applications; fabrication and the design of integrated circuits. PREREQUISITE: EC2100.

EC2220 APPLIED ELECTRONICS (2-4).

A project course covering the design and applications of analog and digital integrated circuits (ICs). Includes an introductory overview of important communications ICs and practical experimental design, constructions, and testing of circuits and systems using these devices. PREREQUISITES: EC2200 and EC2500.

EC2270 BASIC ELECTRONIC AND ELECTRICAL MACHINES (4-2).

An introductory course for non-electrical engineering majors and a continuation of EC2170. Topics include fundamentals of electronics, operational amplifiers, fundamentals of semiconductors, diodes and diode circuits, bipolar junction transistors and applications, junction field effect transistors and applications, principles of electromechanics, and dc machines and ac machines. PREREQUISITES: EC2170 or consent of instructor.

EC2300 CONTROL SYSTEMS. (3-2).

The application of feedback principles to the design of linear control systems using frequency domain (Bode-Nichols), s-domain (root locus) and state variable methods. Performance criteria including steady-state accuracy, transient response specifications, bandwidth and integral performance indices are presented. Laboratory work includes testing and evaluation of physical systems and design studies. Discoveries include five control systems, ship steering autopilots, etc. PREREQUISITE: EC2410.

EC2320 LINEAR SYSTEMS (3-0).

Formulation of system models including state equations, transfer functions, and system diagrams for continuous and sampled-data systems. Computer and analytical solution of system equations. Stability, controllability, and observability are defined. Introduction to design by pole placement using state feedback. Application to military systems is introduced via example. PREREQUISITES: Laplace transform, differential equations, linear algebra, and FORTRAN or other high level languages.

EC2400 DISCRETE SYSTEMS (3-1).

Principles of discrete systems, including modeling, analysis and design. Topics include difference equations, convolution, stability, bilateral z-transforms and application to right-sided and left-sided sequences, system diagrams and realizations, and frequency response. Simple digital filters are designed and analyzed. PREREQUISITE: MA2051 (may be concurrent) and ability to program in a high level language (e.g. MATLAB).

EC2410 ANALYSIS OF SIGNALS AND SYSTEMS (3-1).

Analysis of digital and analog signals in the frequency domain; properties and applications of the discrete Fourier transform, the Fourier series, and the continuous Fourier transform; analysis of continuous systems using convolution and frequency domain methods; applications of sampling, windowing, and amplitude modulation and demodulation systems. PREREQUISITE: EC2400.

EC2450 ACCELERATED REVIEW OF SIGNALS AND SYSTEMS (4-0).

An advanced review of continuous and discrete system theory intended for students who have previous education in these areas. Topics covered by each student will depend upon background and competence in the subject matter of EC2400, EC2410, and EC2320. PREREQUISITE: Sufficient background in linear systems theory. Graded on Pass/Fail basis only.

EC2500 COMMUNICATIONS SYSTEMS (3-2).

In this first course on the electrical transmission of signals, the theory, design, and operation of analog and digital communication systems are investigated. Included are A/D conversion, modulation, demodulation, frequency division multiplexing, and time-division multiplexing. PREREQUISITE: EC2410.

EC2600 ELECTROMAGNETIC FIELDS AND WAVES (4-0).

Static field theory is developed from physical and mathematical principles. Time-varying Maxwell equations are developed and solutions to the wave equations are presented. Additional topics include boundary value problem solutions, plane wave propagation in vacuum and materials. PREREQUISITE: MA2051 or equivalent.

EC2610 ELECTROMAGNETIC ENGINEERING (3-1).

A continuation of EC2600. Topics include the analysis and design of transmission lines, waveguides, resonators, and high frequency components. Applications of military and other interest are presented in the laboratory. PREREQUISITE: EC2600.

EC2650 ACCELERATED REVIEW OF ELECTROMAGNETICS (4-2).

A comprehensive review of basic electromagnetic theory intended for students who have previously studied the subject matter of EC2600 and EC2610. PREREQUISITE: Sufficient background in electromagnetic theory. Graded on Pass/Fail basis only.

EC2800 INTRODUCTION TO MICROPROCESSORS (3-2).

An introduction to the organization and operation of microprocessors and microcomputers, both key embedded elements of military systems. Topics include: the instruction set, addressing methods, data types and number systems, stack and register organization, exception processing, assembly language, programming techniques including macros, assembly language, implementation of typical control structures, data structures, and subroutine linkage methods. Laboratory sessions teach a systematic method for program design and implementation. The laboratory assignments consist of a series of program which collectively implement a major software project. PREREQUISITES: A high level language and EC2820 (may be concurrent).

EC2820 DIGITAL LOGIC CIRCUITS (3-2).

An introductory course in the analysis and design of digital circuits. These circuits are the basis for all military computers and digital control systems. No previous background in digital concepts or electrical engineering is assumed. Topics include: Boolean algebra, truth tables, logic gates, integrated circuit families, decoders, multiplexers, arithmetic circuits, PLAs, ROMs, design of combinational circuits using SSI and MSI components, sequential logic including latches, flip-flops, registers, counters, and memories, analysis and design of synchronous circuits using state tables and state diagrams. The laboratories are devoted to study of combinational and sequential circuits and include a sequence of design projects involving increasingly complex digital functions. PREREQUISITE: None.

EC2890 DIGITAL CIRCUIT DESIGN LABORATORY (0-6).

A laboratory course in the design of digital circuits. Several projects with relevance to naval and other military applications will be completed involving design with MSI components and hardware and software control of external events with a microprocessor. Students are free to choose their projects according to their interests. PREREQUISITE: EC2800.

EC2990 DESIGN PROJECTS IN ELECTRICAL ENGINEERING (0-8).

Design projects under the supervision of faculty members. Individual or team projects involving the design of devices or systems. Projects will typically be in support of faculty members. PREREQUISITE: Consent of instructor. Graded on Pass/Fail basis only.

EC3100 ADVANCED CIRCUIT ANALYSIS (3-1).

A graduate level course in circuit and network analysis. The course considers three phase power systems, mutual inductance and transformers, network functions, stability, convolution, the matrix oriented general network method that embodies the fundamental loop and cut-set matrices and an introduction to network synthesis. PREREQUISITE: EC2100.

EC3130 ELECTRICAL MACHINERY THEORY (4-2).

Topics include a theoretical treatment of magnetic fields and circuits, principles of electromechanics, ac machines, and dc machines. The course will include an introduction to state-of-the-art electric machinery analysis techniques utilized by the US Navy. PREREQUISITE: EC3100 or EC2270.

EC3150 SOLID STATE POWER CONVERSION (3-2).

A detailed analytical approach is presented for the operation, performance, and control of the important types of solid state power converters found in Naval shipboard power systems. The course reviews the characteristics of power semiconductor switching devices. A systems approach is used to analyze high power converters: phase controlled rectifiers, line commutated inverters, self-commutated inverters, transistors converters, and switching regulators. PREREQUISITES: EC3100 or EC2270, EC210.

EC3200 ADVANCED ELECTRONICS ENGINEERING (3-2).

This course provides a graduate level treatment of topics in electronic engineering: Characteristics of differential and multistage amplifiers. Transistor frequency response, including Bipolar Junction Transistors (BJT), Junction and Metal Oxide Semiconductor Field Effect Transistors (JFET and MOSFET) and their characteristics and design considerations. Integrated circuit operational amplifier (OPAMP) applications; analysis and design of non-ideal OPAMPs. Applications of JBT and Complimentary Metal Oxide Semiconductors (CMOS) in integrated circuits, and different biasing techniques. Analysis and design of digital circuits, including Transistor-Transistor Logic (TTL), Emitter Coupled Logic (ECL) and CMOS logic families. Applications and design of feedback amplifiers with applications in analog filters and oscillators. PREREQUISITE: EC2200.

EC3210 INTRODUCTION TO ELECTRO-OPTICAL ENGINEERING (3-1).

An overview of the elements that comprise current electro-optical and infrared (EO/IR) military systems. Topics include radiation sources (both laser and thermal), detector devices, modulators, optical elements, and propagation characteristics. Examples of the application of the concepts taught to various military EO/IR systems such as missile seekers, laser communications, and laser designators are discussed. PREREQUISITE: EC3200.

EC3310 LINEAR OPTIMAL ESTIMATION AND CONTROL (3-1).

Techniques of optimal control and estimation theory and their application to military systems. Topics include performance measures; dynamic programming, the linear regulator problems; state estimation using observers and Kalman filters; Monte Carlo simulation; combined estimation and control and case studies. PREREQUISITES: EC2300 and EC3410 or EC3500 (may be concurrent).

EC3400 DIGITAL SIGNAL PROCESSING (3-1).

The foundations of one and two-dimensional digital signal processing techniques are developed. Topics include fast Fourier transform (FFT) algorithms (1-D and 2-D), block convolution, the use of DFT and FFT to evaluate convolution (1-D and 2-D), elements of multirate signal processing and rate conversion, and design methods for 1-D nonrecursive digital filters. Computer-aided design techniques are emphasized. Introduction to time-frequency representation through the short-time Fourier transform and wavelet transforms. The algorithms introduced have direct applications in sonar and radar signal processing, IR sensor arrays, modern navy weapon systems, and also in voice and data communications. PREREQUISITE: EC2410.

EC3410 DISCRETE-TIME RANDOM SIGNALS (4-0).

Fundamentals of discrete-time random processes are developed from a probabilistic and statistical point of view for digital signal processing, control, and communications. Topics covered are random vectors and description of discrete-time random signals, sampling of continuous-time random signals, statistical averages and second moment analysis, linear transformations, and fundamentals of estimation theory. Subject matter also includes FIR optimal (Wiener) filtering, and an introduction to linear prediction. PREREQUISITES: EC2410, EC2010, and MA3046.

EC3420 STATISTICAL DIGITAL SIGNAL PROCESSING (3-1).

Modern naval systems are highly dependent on advanced statistical signal processing techniques. Modern methods of digital signal processing are developed in this course from a statistical point of view. Methods are developed for processing random signals through statistical data analysis and modeling. Topics include the IIR Wiener filter and the scalar form of the Kalman filter, linear prediction, MA, AR, and ARMA signal modeling, lattice structures, and an introduction to classical and modern methods of spectrum estimation. PREREQUISITE: EC3410.

EC3450 FUNDAMENTALS OF OCEAN ACOUSTICS (4-0).

Introduction to various mathematical techniques (both exact and approximate), special functions (e.g., Bessel functions, Hankel functions, and Legendre polynomials), orthogonality relationships, etc, that are used to solve problems concerning the radiation, scattering and propagation of sound in fluids. Topics in underwater acoustics are emphasized and include, for example, general solutions of the three-dimensional Helmholtz equation in rectangular, cylindrical, and spherical coordinate with Dirichlet, Neumann, and Robin boundary conditions; ocean waveguide models including normal modes and a full-wave pulse propagation solution, sound propagation in the ocean, the WKB approximation, ray acoustics, and the parabolic equation approximation. PREREQUISITES: EC2610 or MA3132 or consent of instructor.

EC3500 RANDOM PROCESSES AND APPLICATIONS (4-0).

Fundamental concepts and useful tools for analyzing non-deterministic signals and noise in military communication, control, and signal processing systems are developed. Topics include properties of random processes, correlation functions, energy and power spectral densities, linear systems and mean square estimation, noise models and special processes. PREREQUISITES: EC2500 (may be concurrent) and EC2010, or consent of instructor.

EC3510 COMMUNICATIONS ENGINEERING (3-1).

The influence of noise and interference on the design and selection of hardware in practical communication transmitters and receivers is analyzed. Specific topics include link budget analysis and signal-to-noise ratio calculations, receiver noise performance for various modulation schemes, bandwidth trade-offs, and hardware parameters. Examples of military communications systems are included. PREREQUISITES: EC2220 and EC3500.

EC3550 FIBER OPTIC SYSTEMS (3-1).

An introduction to the components and to the concepts of designing fiber optic communications systems for military applications. Includes fiber properties and parameters, fiber fabrication and testing, LED and injection laser sources, pin photodiodes and avalanche photodiode detectors, receiver design considerations, connector and splice techniques, and system design incorporating analysis and trade-offs. Data distribution techniques are also studied. PREREQUISITES: EC2220 and EC2600.

EC3600 ELECTROMAGNETIC RADIATION, SCATTERING AND PROPAGATION (3-2).

The principles of electromagnetic radiation are applied to antenna engineering and scattering. The characteristics of various practical antenna types are considered including arrays and reflectors. Scattering concepts are introduced and propagation phenomena are considered. Applications include sidelobe suppression, radar target scattering and stealth approaches, HF and satellite communications. PREREQUISITE: EC2610 or equivalent.

EC3610 MICROWAVE ENGINEERING. (3-2).

This course provides an overview of the circuits and devices used in microwave radar communication and electronic warfare systems. The course covers network analysis using scattering parameters, transmission media, using both hardware and computer simulation. PREREQUISITE: EC2610.

EC3630 RADIOWAVE PROPAGATION (3-0).

This course treats the effects of the earth and its atmosphere on electromagnetic waves in the frequency range up to about 300 GHz. Topics covered include ground waves, sky waves, meteor burst, scatter, ducting reflection, refraction, diffraction, attenuation, and fading. Basic theory is covered and computer models are introduced where appropriate. Emphasis is placed on determination of the transmission loss between transmitting and receiving antennas. Antenna parameters are covered briefly. PREREQUISITE: EC3600.

EC3650 COMPUTATIONAL ELECTROMAGNETIC MODELING TECHNIQUES (4-1).

This a "hands on" course on numerical solution of static, time-harmonic and transient electromagnetic field problems of the type encountered in radar and electronic warfare. One numerical technique for each of the two broad categories of integral and differential techniques is taught: Method of Moments (MOM) for static and time-harmonic field problems and Finite Difference (FD) for static, time-harmonic, and transient electromagnetic field problems. Applications include planar transmission lines, radiation and scattering by thin wires, waveguide and cavity modes, and transient scattering by perfectly conducting objects of simple shape. Students write their own computer codes to implement the techniques taught in class, using a high-level programming environment such as MATLAB or Mathcad. Commercial and "in-house" numerical electromagnetic codes are introduced in the laboratory. PREREQUISITE: EC3600 or consent of instructor.

EC3670 PRINCIPLES OF RADAR SYSTEMS (4-2).

For students in the Avionics and Weapons curricula. Topics include microwave devices, microwave propagation, antenna fundamentals, electronically steerable arrays, pulse radar basics, detection of signals in noise, the radar equation, CW, pulse doppler, moving-target indicators, pulse compression, the ambiguity function, tracking radars, conical scan, track-while-scan, scan with compensation and monopulse. PREREQUISITES: Consent of instructor, U.S. citizenship and SECRET clearance.

EC3800 MICROPROCESSOR BASED SYSTEM DESIGN (3-2).

Advanced microprocessor system concepts are studied. Microprocessor systems are widely used for embedded control in military systems as well as for stand-alone computers. Topics covered are CPU operation and timing, address decoding, typical LSI support chips, exception processing, design of static and dynamic memory systems,

worst-case timing analysis, bus arbitration, and direct memory access controllers. The laboratory consists of a design project integrating hardware and software using a state-of-the-art development system. **PREREQUISITE:** EC2800 and EC2820.

EC3820 COMPUTER SYSTEMS (3-1).

The course presents a unified approach for the design of computer systems stressing the interacting processes implemented in hardware, software and firmware. General features of operating systems are studied as well as specific features of an existing system. The laboratories involve programming in C. Elements of multiprogramming systems are introduced. **PREREQUISITE:** EC2800.

EC3830 DIGITAL COMPUTER DESIGN METHODOLOGY (3-2).

A design and project oriented course covering basic principles, theories and techniques for practical design of digital systems. Emphasizes an integrated viewpoint combining essential elements of classical switching theory with a thorough understanding of the versatility of modern integrated circuits. Laboratory introduces modern design aids. Current military and commercial systems are used as design examples. **PREREQUISITE:** EC2820.

EC3840 INTRODUCTION TO COMPUTER ARCHITECTURE (3-1).

Introduction to computer organization. Fundamental principles in computer design, performance, and cost trade-offs. Instruction set architecture. Processor implementation techniques. Introduction to pipelining. Memory hierarchy design. Principles governing design of processors for embedded and military environments. Input-output subsystems for defense applications. **PREREQUISITES:** EC2800 and EC2820.

EC3850 COMPUTER COMMUNICATIONS METHODS (3-0).

The course objective is to develop an understanding of computer communications networks with emphasis on the requirements of military environments and the US Navy's combat platforms. Coverage includes the essential topics of network topology, connectivity, queuing delay, message throughput, and cost analysis. The layered network architectures, such as the International Standards Organization (ISO) model and GOSIP consisting of the physical, data link, network, transport, session, presentation, and application layers, are covered extensively. The techniques and protocols used in these layers are discussed with emphasis on secure, reliable, and real-time information transfer. Local area networking technologies such as Ethernet, ring, satellite link, X.25 public packet switching, and FDDI are introduced. **PREREQUISITE:** EC2010.

EC3910 SIGINT SYSTEMS I (3-2).

Exposure to the National Signals Intelligence (SIGINT) systems with focus on tasking, exploitation, collection, processing, and dissemination of SIGINT product derived by special SIGINT systems. This course focuses on applying numerical and analytical techniques to exploit realistic navigation, communications, radar, telemetry and other threat target sets critical to National Security. A thorough review on fundamentals in radar and communications to include the utilization of spread spectrums by these systems will be discussed. The analysis of digital systems for SIGINT measurements performed are: encoding/decoding, multiplexing/demultiplexing, modulation/demodulation, application of probability theory, digital transmissions, Signal-to-Noise, bit error rate, bandwidth efficiency, power budget equation, and polarization. Emphasis is placed on math principle of orbital dynamics. **PREREQUISITE:** EO3503 or EC2500 and equivalent, or consent of instructor, U.S. Citizenship and TOP SECRET SCI level clearance.

EC4000 FUTURE ENGINEERING PRACTICE (3-0).

This course discusses the fundamental concepts and practices of electrical engineering history, especially computer simulations (including AI), so that students can see trends and make some guesses as to their future. It primarily concentrates on students, their problems in learning new things as technology and careers continue to progress. The

course, to some extent, adapts itself to the interests of the students enrolled, but much is a survey of the fundamentals of engineering theory and practice and projections into the future. **PREREQUISITE:** Consent of instructor. Graded on Pass/Fail basis only.

EC4010 DEFENSE SYSTEMS ENGINEERING (3-1).

Introduction to systems engineering concepts and methods for the design and integration of complex defense systems, with emphasis on electrical engineering applications. Familiarity with the systems engineering process is developed through case studies of representative defense systems and a group design project which includes determination of system requirements from mission needs and operational requirements. Digital simulation models, including those in current use by DoD, are used to determine engineering and performance trade-offs. **PREREQUISITES:** Four quarters in an NPS engineering curriculum or equivalent; MN3301 (may be concurrent) or consent of instructor.

EC4130 ADVANCED ELECTRICAL MACHINERY SYSTEMS (4-2).

Advanced detailed and reduced order representations and simulations of shipboard electrical machinery via Park's transformation and rotating reference frame theory. Computer-aided steady-state and dynamic analysis studies of current and future shipboard electrical machinery systems. **PREREQUISITE:** EC3130.

EC4150 ADVANCED SOLID STATE POWER CONVERSION (4-1).

Design and analysis of modern power electronic drives with particular emphasis on electric drives for present and future ship propulsion systems and variable frequency/variable speed power converters for advanced shipboard electric power distribution. Electrical and mechanical systems compatibility and electrical system interfacing topics are addressed. **PREREQUISITE:** EC3150 or consent of instructor.

EC4210 ELECTRO-OPTIC SYSTEMS ENGINEERING (3-0).

Advanced topics and application of electro-optics. Military applications of electro-optic and infrared technology such as laser communications, laser radar, and Bragg cell signal processors. Signal-to-noise analysis of laser detector performance. Student reports on EO/IR topics of current military interest. **PREREQUISITE:** EC3210.

EC4220 INTRODUCTION TO ANALOG VLSI (3-1).

Modern active circuit design topologies; analog and sample data networks. Analysis of transfer function properties, stability and causality. Higher order filter design and synthesis. Use of computer simulation tools, SPICE, and different device models for network analysis. Transformation methods and switched-capacitor filtering and non-filtering applications. Introduction to analog VLSI techniques using stray-insensitive switched-capacitor networks. Examples of such analog VLSI designs in military applications. **PREREQUISITES:** EC3200 and EC3400.

EC4300 ADVANCED TOPICS IN MODERN CONTROL SYSTEMS (3-0).

Advanced topics and current developments in control theory and applications including such subjects as: the calculus of variations and Pontryagin's minimum principle applied to optimal control problems; numerical solution of two-point boundary-value problems; nonlinear estimation techniques; robust design techniques; large-scale systems; system identification; case studies of fire control and ship control systems. **PREREQUISITE:** Consent of instructor.

EC4320 DESIGN OF LINEAR CONTROL SYSTEMS (4-0).

Advanced concepts in the design of linear, nonlinear, and digital control systems. Frequency response, root locus, state feedback, parameter plane, and optimization methods are used. Applications focus on aircraft, missile, and ship control systems. SISO and MIMO systems are optimized using function minimization subroutines. Sliding mode controls are discussed. **PREREQUISITE:** EC3310 or consent of instructor.

EC4330 NAVIGATION, MISSILE, AND AVIONICS SYSTEMS (Classified)(2-2).

The principles of operation of navigation, missile, and avionics systems are presented. Topics are selected from the following areas to address the specific interests of the class: IR, EO, radar laser, and acoustic sensors; inertial platforms; gyros and accelerometers; Loran, Omega, GPS, INS guidance, fire control and tracking systems. **PREREQUISITES:** EC3310, U.S. citizenship and Secret clearance.

EC4340 NAVIGATION, MISSILE, AND AVIONICS SYSTEMS (Unclassified)(2-2).

This course covers essentially the same material as EC4330, but with deletion of detailed analysis of specific systems. This course is intended for officers who do not have U.S. citizenship. **PREREQUISITE:** EC3310.

EC4350 NONLINEAR CONTROL SYSTEMS (3-1).

Automatic control of nonlinear systems with application to military systems. Analysis and design of nonlinear systems with phase plane and describing function methods. Accuracy limit cycles, jump resonances, relay servos, and discontinuous systems are considered. **PREREQUISITE:** EC3310.

EC4360 SYSTEM MODELING AND IDENTIFICATION (3-1).

Design and analysis techniques of control and signal processing systems are based on a mathematical model of the system to be controlled (the plant) or a model of the environment in which they are operating (a communication channel). In this course we address the problem of identifying mathematical models for systems based on input/output signals. Particular attention is given to linear stochastic autoregressive models of physical systems, and techniques to identify their parameters and validate the estimates. Both off line and on line (recursive) identification techniques are presented together with their properties in terms of convergence. **PREREQUISITE:** EC3310.

EC4370 MODELING AND SIMULATION FOR CONTROL SYSTEMS (4-0).

Modeling concepts and techniques for linear and nonlinear systems. Philosophy of model studies. Verification of the model and its parameters. Design studies using computer models are applied to shipsteering, replenishment at sea, high speed motion picture cameras, and other naval equipment. **PREREQUISITE:** EC2300.

EC4400 ADVANCED TOPICS IN SIGNAL PROCESSING (3-0).

Special advanced topics in signal processing not currently covered in a regularly scheduled course and relevant to advanced naval and other military applications. Topics may include digital filter structures and implementations, advanced computational topics and architectures for signal processing, imaging, recent work in signal modeling, array processing, or other topics of interest. **PREREQUISITE:** EC3420 or consent of instructor.

EC4410 SPEECH SIGNAL PROCESSING (3-1).

This course covers methods of digital signal processing as they are applied to speech communication for transmission, encryption, and recognition. The production and perception mechanisms are discussed. Topics include speech modeling analysis, synthesis, coding including LPC, and speech and speaker recognition. The techniques introduced here are also applied to sonar signal processing, voice controlled remote security and access, voice operated aircraft control, and others areas. **PREREQUISITES:** EC3400 and EC3420 or consent of instructor.

EC4420 MODERN SPECTRAL ANALYSIS (3-1).

Spectral estimation is the key to passive sonar detection, tracking, and identification. It also plays a dominant role in radar/sonar signature evaluation and in a majority of signal processing applications as they apply to the weapons technology of DoD. Classical and modern spectral estimation are developed from their basic ideas and compared in terms of performance and implementation. Topics covered are Fourier-based, model-based and eigenspace-based estimators, as well as Capon's method and Prony's method. Nonstationary spectral estimation schemes are discussed, in

particular the Wigner-Ville distribution and the instantaneous power spectrum. Array processing is discussed from classical, model-based and eigenspace-based perspectives. Additional topics are cepstral analysis, higher order spectral estimators, and coherency. PREREQUISITES: EC3400 and EC3420.

EC4450 SONAR SYSTEMS ENGINEERING (4-1).

Mathematical development and discussion of fundamental principles that pertain to the design and operation of passive and active sonar systems critical to naval operations. Topics from complex aperture theory, array theory and signal processing are covered. This course supports the underwater acoustics and antisubmarine warfare curricula and others. PREREQUISITES: EC3450 or PH3452 or PH3402 and one of EC3410 or EC3500 or EO3402.

EC4470 ADAPTIVE SIGNAL PROCESSING (3-1).

Introduction to the theory of adaptive signal processing for random sequences. Topics covered include: review of Wiener filters and one-step forward linear prediction-error filters; one-step backward linear prediction error filters; analysis and synthesis lattice prediction-error filters; adaptive tapped-delay-line filters using steepest descent, least-mean-squares (LMS) and recursive least-squares (RLS) algorithms; and adaptive lattice filters. PREREQUISITES: EC3400 and EC3420.

EC4480 IMAGE PROCESSING AND RECOGNITION (3-2).

This course provides image processing background for understanding modern military applications such as long range target selection, medium range identification, and short range guidance of new weapons systems. Subjects include image representation, enhancement, restoration, transformation, and encoding. Pattern recognition using statistical decision theory is discussed briefly. Some analysis involving region segmentation and block world understanding is introduced. Some effort is directed toward robotic vision where contemporary techniques used to recognize objects and extract depth information are dealt with briefly. The course contains a series of experiments using peripherals and computers. PREREQUISITE: EC3400.

EC4490 OCEAN ACOUSTIC TOMOGRAPHY (EC/OC4490) (3-0).

An introduction to ocean acoustic tomography, an underwater acoustic inverse technique for mapping ocean sound speed and current fields. Covers the major aspects of ocean acoustic tomography, including the underlying concepts, the design and transmission of tomographic signals, and linear inverse methods for the reconstruction of ocean fields. PREREQUISITE: EC2410 or OC3260 or PH4453 or equivalent. Also offered as OC4490.

EC4500 ADVANCED TOPICS IN COMMUNICATIONS (3-0).

Topics and current developments in communications relevant to advanced naval and other military applications. Offered on an occasional basis with the topics determined by the instructor. PREREQUISITE: Consent of instructor.

EC4550 DIGITAL COMMUNICATIONS (4-0).

This course presents some of the advantages and limitations of modern military M-ary digital communications systems. M-ary modulation formats, matched filter receivers, probability of error calculations, non-coherent receivers, carrier synchronization, symbol synchronization, telephone line modems, wideband modems, bandwidth and signal energy, diversity combining, and Raleigh fading channels are covered. Examples of current operational and proposed military space and earth links are treated. PREREQUISITE: EC3510.

EC4560 COMMUNICATIONS ECCM (3-2).

Methods of reducing the effects of jamming on military radio communications systems are considered. Direct sequence spread spectrum systems and frequency-hopped spread spectrum systems are examined with regard to their LPI, LPD, and AJ capabilities. Time hopping and hybrid systems are also considered. Coarse and fine synchronization problems and techniques are presented. PREREQUISITE: EC3510.

EC4570 SIGNAL DETECTION AND ESTIMATION (4-0).

Principles of optimal signal processing techniques for detecting signals in noise are considered. Topics include maximum likelihood, Bayes risk, Neyman-Pearson and min-max criteria and calculations of their associated error probabilities (ROC curves). Principles of maximum likelihood, Bayes cost, minimum mean-square error (MMSE), and maximum a posteriori estimators are introduced. Asymptotic properties of estimators and the Cramer-Rao bound are developed. Integral equations and the Karhunen-Loeve expansion is introduced. The estimator-correlator structure is derived. Emphasis is on dual development of continuous time and discrete time approaches, the latter being most suitable for digital processing implementation to undertake research in military radar and sonar systems. This course provides students the necessary foundations to PREREQUISITE: EC3410 or EC3500.

EC4580 CODING AND INFORMATION THEORY (4-0).

Digital military communication systems often employ error control coding to improve the effectiveness against jamming. This course together with EC4560 will provide students the necessary foundations for understanding the principles of such systems. Topics include concepts of information measure for discrete and continuous signals; fundamental theorems relating to coding and channel capacity; effects of noise on information transmission; coding methods for error control in digital communications systems. Selected applications of the theory to real systems. PREREQUISITE: EC3410 or EC3500.

EC4590 COMMUNICATIONS SATELLITE SYSTEMS ENGINEERING (3-0).

Communication satellite systems including the satellite and user terminals. Subjects include orbits, power sources, antennas, stabilization, link calculations, multiple access techniques, modulation and demodulation schemes, phase-locked loops, coding, transponder, intermodulation, and hardlimiting receiver design, spread spectrum in SITCOM for multiple access, anti-jam and covert communications. Various military satellite communications systems are introduced. PREREQUISITE: EC3510 (may be concurrent).

EC4600 ADVANCED ELECTROMAGNETICS (3-0).

An introduction is provided to advanced mathematical and numerical techniques of importance in the design and analysis of electromagnetic devices. Applications are considered for radar scattering, low observables, broad-band antennas, surface wave propagation, and microwave techniques. PREREQUISITES: EC3600 or equivalent, and consent of instructor.

EC4610 RADAR SYSTEMS (Classified) (3-2).

The radar range equation is developed in a form including signal integration, the effects of target cross-section, fluctuations, and propagation losses. Modern techniques discussed include pulse compression frequency modulated radar, moving target indicator (MTI) and pulse Doppler systems, monopulse tracking systems, multiple unit steerable array radars, and synthetic aperture systems. Laboratory sessions deal with basic pulse radar systems from which the advanced techniques have developed, with pulse compression, and with the measurement of radar cross-section of targets. PREREQUISITES: EC3410 or EC3500, EC3600, and one among EC3610 and EC3630; U.S. citizenship and SECRET clearance.

EC4620 RADAR SYSTEMS (Unclassified) (3-2).

This course covers essentially the same material as EC4610, but with deletions of detailed analysis of specific items. This course is intended for students who do not have U.S. citizenship. PREREQUISITES: EC3410 or EC3500, EC3600 (or EO3602), and one among EC3610, and EC3630.

EC4630 RADAR CROSS SECTION PREDICTION AND REDUCTION (3-0).

This course covers the design and engineering aspects of stealth and its impact on

platform and sensor design. Signature prediction methods in the radar, infrared (IR) and laser frequency bands are discussed. Radar cross section (RCS) analysis methods include geometrical optics and diffraction theory, physical optics and the physical theory of diffraction and numerical solutions to integral and differential equations. Prediction methods for IR and laser cross sections (LCS) are also introduced. Signature reduction by shaping, materials selection, and active and passive cancellation are applied to each frequency regime. The measurement of these cross sections is also covered. PREREQUISITE: EO3602 or EC3600 or consent of instructor.

EC4660 ELECTROMAG ENVIRONMENTAL EFFECTS ON COMM SYSTEM PERFORMANCE. (3-2).

This course covers the effects of the electromagnetic environment on the performance of VLF-UHF land based and shipboard communications systems with emphasis on SIGINT applications. Methods of evaluating system performance in the presence of electromagnetic interference (EMI) are discussed. Newly developed techniques that overcome shortcomings of classical EMI test procedures of locating and eliminating sources of EMI in order to improve system performance are demonstrated in the laboratory. Current research in non-classical propagation and antenna effects are covered. Computational tools for evaluating these effects are demonstrated. Students participate in a project by applying the test procedures and computer tools to a current military system or sub-system, gaining an appreciation for the impact of the EM environment on operational systems. PREREQUISITE: EC3650 or consent of instructor.

EC4670 ELECTRONIC WARFARE (3-3).

This course is intended for students who are not in the Electronics or Communications Engineering curricula. Three lecture hours are shared with EC4680. In addition to the topics listed under EC4680, background material on communication theory and digital signal processing is presented. PREREQUISITES: EC3670; U.S. citizenship and SECRET clearance.

EC4680 ELECTRONIC WARFARE TECHNIQUES AND SYSTEMS (3-3).

Active and passive countermeasure techniques are considered, including signal representation, signal analysis, and signal interception. Important parameters of radar and communications systems are defined. Denial and deceptive jamming techniques are considered along with countermeasure and counter-countermeasure techniques. Signal intercept systems are treated. Acoustic, radio-frequency, infrared, and optical countermeasures are discussed. PREREQUISITES: EC4610, U.S. citizenship and SECRET clearance.

EC4690 PRINCIPLES OF ELECTRONIC WARFARE (3-2).

For students who do not have U.S. citizenship. The objectives are to define EW signals and systems parameters, and establish interrelationships of these parameters for active and passive EW systems. Topics included are signal waveforms and spectra, receivers, signal processing and display, jamming techniques, direction finding, deception and confusion techniques. Laboratory exercises apply the basic principles of jamming and counter-countermeasures to radar systems. PREREQUISITE: EC4620.

EC4800 ADVANCED TOPICS IN COMPUTER ENGINEERING (3-0).

Advanced topics and current developments in computer architecture including such subjects as: RISC vs. CISC; graphics processors relevant to naval and military applications, and workstations, supercomputers and mini-supercomputers; computer structures for artificial intelligence; massively parallel architectures. PREREQUISITE: Consent of instructor.

EC4810 FAULT TOLERANT COMPUTING (3-2).

This course deals with fundamental principles of making computing more reliable in military environments. Introduction to fault tolerant computing. Fundamental definitions, goals, and applications. Failure modes, fault and error models. Passive, active, and hybrid hardware redundancy. Information, time, and software redundancy. The design of fault tolerant digital systems and VLSI circuits. Testing and evaluation of

digital circuits and systems. Modeling and simulation of mission-critical fault tolerant systems. PREREQUISITES: EC3820 and EC3840.

EC4820 ADVANCED COMPUTER ARCHITECTURES (3 -1).

A study of advances in computer architecture. Topics include computer description languages; memory system issues; high performance computers; pipeline supercomputers; array processors; multiprocessors; data flow architectures; and architectures for special military applications. PREREQUISITES: EC3820, EC3840.

EC4830 DIGITAL COMPUTER DESIGN (3-1).

This course presents digital system design techniques that can be used in tactical embedded systems. It involves a study of the architecture of and the design process for digital computer systems. Topics covered include instruction set architectures, advanced computer arithmetic, hierarchical design techniques, design of systems using standard and custom VLSI devices. Modern computer aided design tools are emphasized. Laboratory project is the design of a digital computer. PREREQUISITES: EC3800 and EC3830.

EC4850 HIGH SPEED NETWORKING (3-2).

The course objective is to develop an understanding of the emerging trends and technologies that enable deployment of a global network for tactical use. Coverage includes characterization of the networking requirements of multimedia DoD applications, ATM/SONET-based Gigabit network architecture, Gigabit LAN protocols, internals of TCP/IP and their viability in future high speed internets, multicast protocols, and principles of mobile internet-working including the DoD Common Data link (CDL) and its interface to the terrestrial internet. The emphasis will be on network and transport layer functionality and evaluation of the bit rates visible to the end-users for a given network architecture specification. PREREQUISITES: EC3850.

EC4870 VLSI SYSTEMS DESIGN (3-2).

An introduction to the architecture and design of very large scale integrated systems. Application to specific architectures for military systems. A structured approach to system design is developed emphasizing CMOS devices and circuits. Basic cells, state machines, and their application to highly regular topologies are studied. Special developments under the DoD VHSIC program and several examples of complete VLSI systems are presented. Project work is oriented to the definition, planning, design, and testing of a complete small system. PREREQUISITES: EC3800 and EC3830.

EC4900 SPECIAL TOPICS IN ELECTRICAL ENGINEERING (V-0).

Supervised study in selected areas of electrical engineering to meet the needs of the individual student. A written report is required at the end of the quarter. PREREQUISITE: Consent of the department chairman. Graded on Pass/Fail basis only.

EC4910 ARRAY SIGNAL PROCESSING (3-1).

The foundations of array signal processing are developed. The procedures covered have direct applications in sonar and radar signal processing and modern navy weapon systems. Introduction to the theoretical aspects of array signal processing and its application in detection and tracking are presented. Topics to be covered include: basic introduction and motivations to array signal processing; basic concepts in wave propagation; classical beamforming; adaptive array processing; and introduction to tracking. PREREQUISITES: EC3400 and EC3410.

EC4920 ULTRA WIDEBAND RADAR (3-0).

Ultra wideband is a newly emerging technology with potential applications in foliage and subsurface penetration, detection of low RCS TARGETS, AND IDENTIFICATION OF TARGETS. Systems based on it will have extremely fine range resolution, encounter

small clutter and have LPI characteristics. Recent developments in high power sources and high power ultra fast switches is making possible the implementation of carrier free radar. This course will review the recent developments in UWB technology and the radar concepts to capitalize on this technology. This course will also deal with other high resolution radar concepts. PREREQUISITES: EC4610/20 or EC3670 or a basic course in radar.

EC4930 DIGITAL SIGNAL PROCESSING HARDWARE (3-2).

The implementation of Digital Signal Processing Algorithms on Hardware systems. Topics covered include The Hardware Architecture for Digital Signal Processors, introduction to the major DSP chipsets, the architecture of the Texas Instruments TMS320 family of DSPs, DSP peripherals, and software tools for implementing algorithms on these systems. The course is designed so that the student can complete a final project implementing a DSP algorithm on one of several available DSP systems. PREREQUISITE: EC3420 and EC3800 or consent of instructor.

EC4940 GEOPOSITIONING SYSTEM (3-2).

Techniques for optimally determining the position of a radio frequency emanation. Topics include geodetic coordinate systems, multi-element directional antennas, interferometry, correlational receivers, time-of-arrival, time-difference-of-arrival, frequency of arrival, and frequency-difference-of-arrival. Discussion includes statistical techniques to determine best point estimates and measures of uncertainty. PREREQUISITES: EC3400, EC3410.

EC4950 COMMUNICATIONS SYSTEMS VULNERABILITY (3-2).

Identifies methods an adversary could use to disrupt or intrude into communication systems, Develops within the open systems reference interface models, those modulation, protocol, and encoding methods most subject to attack. Systems reviewed include common narrowband, time division multiplexing, frequency division multiplexing, and code division multiplexing. Protocols reviewed include TCP/IP, X.24, X.400 and other commercial standards. PREREQUISITES: EC3850 or CS3502, EC2500 or EO2503, U.S. citizenship and SECRET CLEARANCE.

EC4960 ARTIFICIAL NEURAL NETWORKS (3-1).

The course provides a systematic treatment of the important concepts of artificial neural networks; modeling of the brain as an electrical network, learning methods, and training algorithms. Emphasis will be placed on algorithms for implementing simple artificial neural networks that lead to applications of interest in electrical engineering; radar and sonar target classification, speech recognition, scalar and vector quantization, nonlinear time series prediction and others. PREREQUISITES EC3400 and EC3410 or EC3500.

EC4970 BIONIC SONAR (3-0).

The course describes the results of U.S. Navy supported research on dolphin sonar. Dolphin sonar is superior to man-made sonar for short ranges and in shallow waters containing bottom clutter and false targets. As a result, it is superior to man-made sonar in its ability to recognize and classify targets in noisy environments. Potential application of this knowledge is for autonomous underwater mine hunting vehicles. Topics to be covered include: mathematical modeling of the dolphin's sonar system and signal processing models associated with target detection and discrimination. PREREQUISITES: EC3450 and EC4450.

EC4980 SENSOR FUSION, DATA ASSOCIATION AND TARGET TRACKING (3-2).

Fundamentals of sensor fusion, data association and target tracking with military applications. Association algorithms will be taught from the standpoint of the extended Kalman filter (EKF), and this EKF theory will be taught in the course. Topics include:

basic properties of sensors as measuring devices (radar, active and passive, sonar, active and passive, and EO/IR sensor measurement models will be discussed); basic EKF theory and target tracking models; multihypothesis data association algorithms; reduced order probabilistic models; attribute information and heuristic techniques. Examples and projects will be drawn from Radar, EW and ASW. **PREREQUISITES:** Linear System Theory, including state space, and probability theory.

EC4990 RADAR SIGNAL PROCESSING (3-0).

The main objective of this course is to discuss digital signal processing techniques in modern coherent radars (such as airborne radars which detect targets in presence of large ground clutter and other interferences. Radar waveform (or modes) shall be classified as CW, ICW, HPRF, and LPRF. Advantages and limitations of each mode shall be discussed. Practical implementation and the signal processing associated with each mode will be elaborated upon. Applications of these modes will be discussed in the existing radar systems. Concepts and algorithms for the following shall be covered: digital pulse compression, MTI clutter cancellation, doppler analysis by DFT, CFAR detection, ambiguity resolution, synthetic array radar (SAR) processing, doppler beam sharpening and other associated techniques and algorithms. This course will be and continuation of EC 4610/20. **PREREQUISITES:** EC4610/20 and consent of instructor.

EO2402 INTRODUCTION TO LINEAR SYSTEMS (4-1).

A course in the rudiments of linear systems for naval officers in the ASW and EW curricula. Principles of discrete and continuous-time systems. Topics include difference equations, discrete and continuous convolution, correlation, transfer functions, and system diagrams. Transform applications in communication and control systems. **PREREQUISITE:** MA3139.

EO2413 INTRODUCTION TO COMMUNICATIONS SYSTEMS ENGINEERING (4-2).

A first course in communications systems for the C3, Space Systems Operations, and Information Technology Management curricula. Coverage begins with the representation of signals in the time and frequency domains and progresses through linear system analysis using Fourier transform theory. Analog modulation techniques are presented emphasizing communications systems level analysis and spectral representation. Topics include Fourier series, Fourier transforms, linear systems, filters, signals bandwidth, communications channels and amplitude, frequency, and phase modulation. **PREREQUISITE:** MA1248 or equivalent.

EO2602 INTRODUCTION TO FIELDS AND WAVE (4-0).

Static field theory is developed from physical and mathematical principles. Time-varying Maxwell equations are developed and solutions to the wave equations are presented. Additional topics include boundary value problem solutions, plane wave propagation in vacuum and materials. **PREREQUISITE:** Vector calculus.

EO2612 ELECTROMAGNETIC ENGINEERING (3-1).

A continuation of EO2602. Topics include transmission lines, waveguides, resonators, and high frequency components. Applications are presented in the laboratory. **PREREQUISITE:** EO2602.

EO3205 SPACE POWER AND RADIATION EFFECTS (3-1).

Fundamentals of different power systems utilized in spacecraft; photovoltaic power technology; solid-state physics, silicon solar cells, solar cell measurement and modeling, gallium arsenide cells and II-V compounds in general, array designs and solar dynamics. Radiation effects on solid state devices and materials. Survivability of solar cells and integrated circuits in space environment and annealing method. Other space power systems including chemical and nuclear (radioisotope thermoelectric generators, and nuclear reactors). Energy storage devices and power conversion. Spacecraft power supply design. **PREREQUISITE:** SS2001 and EC2200.

EO3402 SIGNALS AND NOISE (4-1).

A course in the rudiments of modern signal processing for the ASW and EW curricula. Topics include signal processing in the frequency domain using the DFT and FFT, random signals, description and processing. Applications to signal detection, demodulation, filtering, beamforming, target tracking, and other relevant naval and military operations. PREREQUISITES: EO2402 and OS2103.

EO3512 COMMUNICATIONS AND COUNTERMEASURES (3-2).

This course, intended primarily for international EW students, is concerned with the transmission of bit streams in a military environment including ECM. The fundamental parameters of a radio system are reviewed. The processes involved in digitizing voice and video are presented. Conventional carrier modulation methods are considered. Modern modulation techniques are studied. Spread spectrum methods including frequency hopping and direct sequence are developed. The effects of jamming are considered in all the topics treated. Computer simulations are employed to study the effects of jamming on digital radio signals (such as ASK, FSK, and PSK) for particular demodulator circuits. PREREQUISITES: EC1010, EC2500 or consent of instructor.

EO3513 COMMUNICATIONS SYSTEMS ENGINEERING (4-2).

The second course in communications systems engineering for the C3, space systems operations, information technology management, and other operational curricula. Coverage begins with a review of Fourier methods and covers analog and digital communications systems. Specific topics include amplitude modulation, angle modulation, the sampling theorem; spectral representation of pulse and digital signals; pulse and digital modulations; baseband coding forms; frequency and time-division multiplexing. PREREQUISITE: EO2413.

EO3523 COMMUNICATIONS SYSTEMS ANALYSIS (4-2).

The final course in communications systems for the Information Technology Management, Joint C3, and Space Systems Operations curricula with emphasis on the relative performance of communications systems and analysis of trade-offs available in system design. Specific topics include comparative performance of analog and digital modulation types in the presence of noise; antenna characteristics; propagation effects on signal transmission; and end-to-end path calculations for wire/coax, optical fiber and RF systems. Partially satisfies Education Skill Requirements (ESRs) for an applied, systems-level understanding of analog and digital communications systems and technologies. PREREQUISITE: EO3513.

EO3602 ELECTROMAGNETIC RADIATION, SCATTERING AND PROPAGATION (4-2).

The fundamentals of antennas used in the VLF through the microwave portion of the electromagnetic spectrum are presented. Scattering and propagation in this part of the spectrum are also discussed, as are those elements of electromagnetic compatibility which relate to radiation. Laboratory experiments relating to pattern and impedance measurement further enhance the student's understanding of the lecture concepts. PREREQUISITE: EO2602.

EO3802 ELECTRONIC WARFARE COMPUTER APPLICATIONS (3-2).

Application of high-speed digital, analog, and optical techniques to the storage, processing, display, and interpretation of electronic warfare signals and data. High-speed digital architectures, integrated optical architectures, and neural networks for processing EW signals are treated. PREREQUISITES: EC2820, EO3402, PH3208.

EO3816 COMPUTER ARCHITECTURES FOR MILITARY APPLICATIONS (3-0).

The course objective is to develop an understanding of the fundamental concepts in modern computer architectures as they relate to the computations required in signal processing for military applications. Uniprocessor and parallel processor architectures are studied with emphasis on their use rather than design. Emphasis is laid on the determination of computation and communication bandwidth requirements of typical signal processing algorithms used in military environments and identification of possible performance bottlenecks in various single and multiple processor systems. **PREREQUISITE:** Ability to program in a high level language.

EO3911 INTRODUCTION TO SIGINT (3-0).

An introduction to the concept and methods toward the execution of Signals Intelligence (SIGINT) operations within the Intelligence community will be examined thoroughly. The authority and processes used to manage SIGINT Systems (USSS) in order to efficiently and effectively respond to SIGINT requirements and the actual mechanism to exploit, collect, process and disseminate SIGINT products will be discussed. This course will provide the student with in-depth knowledge of the National Security Agency/Central Security Service (NSA/CSS) SIGINT operations. This course will also introduce other military Intelligence components and agencies in-support to SIGINT OPS. A thorough review of COMINT, ELINT, FISINT and other areas of SIGINT will be discussed at the National and Tactical systems level. **PREREQUISITE:** U.S. Citizenship and TOP SECRET SCI level clearance.

EO4011 SYSTEMS ENGINEERING FOR ACQUISITION MANAGERS (3-1).

An introduction to the discipline of system engineering and how it is applied over the life cycle of a product. Topics include: the system approach and system design process; translation of mission needs and operational requirements into system technical requirements; the role of performance analysis and tradeoffs in conceptual system design; functional de-composition of systems requirements into element and equipment requirements; designing for reliability, survivability, readiness, maintainability, and supportability; the role of test and evaluation as a quality control technique over the life cycle; system development, production, and operational documentation; the role of system engineering in the DoD acquisition cycle and project management. Intended for acquisition management students. **PREREQUISITES:** MN3301 and OS3006 or consent of instructor.

EO4602 ELECTRO-OPTIC SYSTEMS AND COUNTERMEASURES (3-0).

A study of military applications of electro-optic systems, IR and EO missile seekers, laser designators, optical surveillance, high energy laser systems, laser communications, and laser radar. Emphasis is on system applications, countermeasures and counter-countermeasures. Students report on electro-optic systems. **PREREQUISITES:** PH3208 or EC4210, U.S. citizenship and SECRET clearance.

EO4612 MICROWAVE DEVICES AND RADAR (4-2).

Those microwave devices most important in radar and in electronic warfare systems are studied, including magnetrons, traveling-wave tubes, and solid-state diodes. The radar range equation is developed. In addition to basic pulse radar, modern techniques are discussed including Doppler systems, tracking radar, pulse compression, and electronically steerable array radars. Electromagnetic compatibility problems involving radar systems from which the advanced techniques have developed, with performance measurement methods, automatic tracking systems, pulse compression, and the measurement of radar cross-section of targets. **PREREQUISITES:** EO3602 (may be concurrent) or consent of instructor; U.S. citizenship and SECRET clearance.

EO4622 ELECTRONIC WARFARE SYSTEMS (3-2).

This course covers electronic warfare in that portion of the electromagnetic spectrum through the millimeter wavelength region. The infrared through electro-optic region is covered in a companion course, EO4602. Electronic denial and deceptive countermeasure against fuses, communications, and various radar detection and tracking systems are discussed. Equations for required jammer gain and power output are developed. The characteristics of passive countermeasures are discussed. Other topics include anti-radiation missiles, counter-countermeasure circuits, target masking and modification, signal intercept, signal sorting, signal identification and direction finding. Techniques are discussed in relation to U.S., allied, and communist bloc systems. Laboratory work reinforces the classroom discussions. PREREQUISITES: EO4612, U.S. citizenship and SECRET clearance.

EO4903 C3 COUNTERMEASURES (Variable Credit) (V-0).

Supervised study in selected areas of electronic warfare to meet the needs of individual students. A written report is required at the end of the quarter. PREREQUISITE: Consent of C3 group chairmen. Graded on a Pass/Fail basis only.

EO4911 EO4921... EO4991 ADV INTERDISCIPLINARY STUDIES IN ELEX-COMP (V-0).

These courses examine advanced topics of joint interest to electrical and computer engineering and other areas. PREREQUISITE: Consent of instructor.

ELECTRONIC WARFARE ACADEMIC GROUP

Mike Bailey, Professor (OR, X2085)
Ernie Beran, Lt.Col. (USAF) Military
(X3117 or 2772)
Mitch Brown, Professor (NS, X2286)
Alf Cooper, Professor (PH, X2452)
Ken Davidson, Professor (MR, X2309)
Wayne Hughes, Professor (OR, X2484)
Dave Jenn, Professor (EC, X2254)
Bob Kali, LCDR, (X2213) Military
Jeff Knorr, Professor (EW, X2214) *
Mike Morgan, Professor (EC, X2081)
Phil Pace, Professor (EC, X3286)
Curt Schleher, Professor (E , 3767)
Don Wadsworth, Professor (EC, X2115)
Bob Young, CDR (X2136 or 2135) Military

Chairman:
Frederic H. Levien
Professor
Code EW, Spanagel Hall
Room 220
(408) 656-2476
(408) 656-2535

Academic Associate:
David Jenn
Associate Professor
Code EG/Ko, Spanagel Hall
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(408) 656-2254/2082
DSN 878-2254/2082

*Acting Chairman

The Electronic Warfare Academic Group is an interdisciplinary group of faculty representing various academic disciplines. The Electronic Warfare Academic Group has administrative responsibility for the academic content of the Electronic Warfare curricula. Teaching in this multidisciplinary program is carried out by faculty members attached to the following academic departments: Electrical and Computer Engineering, Mathematics, Meteorology, Operations Research and Physics. Thesis topics for students in this area of study are approved by the group and the thesis is approved by the chairman.

MASTER OF SCIENCE IN SYSTEMS ENGINEERING

The degree Master in Science in Systems Engineering will be awarded at the completion of a multidisciplinary program, either Curriculum 595 or 596.

The Master of Science in Systems Engineering requires a minimum of 45 quarter hours of graduate-level work of which at least 15 hours must represent courses at the 4000 level. Graduate courses in at least four different academic disciplines must be included and in two disciplines, a course at the 4000 level must be included.

An approved sequence of at least three courses constituting advanced specialization in one area must be included.

In addition to the 45 graduate hours of course work, an acceptable thesis must be completed.

COURSE OFFERINGS

EW0002 SEMINAR. (NO CREDIT) (0-1).

Special lectures and discussion of matters related to the EW program.

PREREQUISITE: SECRET clearance.

EW0810 THESIS RESEARCH/GROUP PROJECT. (0-8).

Students in the Systems Engineering curricula will enroll in this course which consists of an individual thesis or a group project involving several students and faculty.

EW4000 APPLICATIONS OF SPACE AND ELECTRONIC WARFARE. (4-0).

Review of weapons and sensor systems associated with Space and Electronic Warfare. Overview of space science to include space environment, orbital mechanics, propulsion and launch vehicles, spacecraft subsystems, periods of vulnerability and launch windows. Current SEW doctrine and fleet tactics are discussed in conjunction with briefs on current military threats. **PREREQUISITES:** EO4780 or consent of instructor and TOP SECRET clearance with eligibility for SI/SAO. US. citizenship.

ENGINEERING ACOUSTICS ACADEMIC COMMITTEE

Chairman:

Anthony A. Atchley
Associate Professor
Code PH/Ay, Spanagel Hall
Room 114
(408) 656-2848
DSN 878-2848

The academic character of the programs in Engineering Acoustics is interdisciplinary, with courses and laboratory work drawn principally from the fields of physics and electrical engineering. Although broadly based, the emphasis of the programs is on those aspects of acoustics, signal processing and computers related to underwater sound propagation, electro-acoustic transduction and the detection, tracking and quieting of underwater targets. These programs are designed specifically for students in the Combat Systems Science and Technology and the Undersea Warfare curricula and government employees in acoustics-related laboratories and systems commands.

The academic aspects of the MS program are the responsibility of an academic committee composed of representatives from the Departments of Physics and Electrical and Computer Engineering.

MASTER OF SCIENCE IN ENGINEERING ACOUSTICS

The degree Master of Science in Engineering Acoustics will be awarded as an interdisciplinary program in accordance with the following degree requirements:

- 1) A student pursuing a program leading to a Master of Science in Engineering Acoustics must have completed work which would qualify him/her for a Bachelor of Science degree in engineering or physical science. Credit requirements for the Master of Science degree must be met by courses in addition to those used to satisfy this requirement.
- 2) The Master of Science in Engineering Acoustics requires a minimum of 36 graduate credit quarter hours of course work; at least 20 graduate quarter hours must be taken in acoustics and its applications. One 4000 level course from each of three of the following areas must be included: wave propagation, transducer theory and design sonar systems and signal processing.
- 3) An acceptable thesis must be completed.

Approval of each program by the Engineering Acoustics Academic Committee must be obtained prior to reaching the mid point of the degree program.

DOCTOR OF PHILOSOPHY AND DOCTOR OF ENGINEERING

The Department of Electrical and Computer Engineering and the Department of Physics jointly sponsor an interdisciplinary program in Engineering Acoustics leading to either the degree Doctor of Philosophy or Doctor of Engineering. Areas of special strength in the departments are physical acoustics, ocean acoustics and acoustic signal processing. A noteworthy feature of this program is that a portion of the student's research may be conducted away from the Naval Postgraduate School at a cooperating laboratory or other Federal Government installation. The degree requirements and examinations are as outlined under the general school requirements for the doctor's degree. In addition to the school requirements, the departments require a preliminary examination to show evidence of acceptability as a doctoral student.

DEPARTMENT OF MATHEMATICS

Carlos Borges, Assistant Professor (1991)*; PhD, University of California, Davis, 1990.

David Canright, Associate Professor (1988); PhD, University of California at Berkeley, 1987.

Donald Alfred Danielson, Professor (1985); PhD, Harvard University, 1968.

Fariba Fakhroo, Assistant Professor (1992); PhD, Brown University, 1991.

Richard Franke, Professor and Chairman (1970); PhD, University of Utah, 1970.

Harold M. Fredricksen, Professor (1980); PhD, University of Southern California, 1968.

Christopher Frenzen, Associate Professor (1989); PhD, University of Washington, 1982.

William Gragg, Professor (1987); PhD, University of California at Los Angeles, 1964.

Teresa Henson, Lecturer (1991); MS, University of Colorado at Denver, 1989.

Van Emden Henson, Assistant Professor (1991); PhD, University of Colorado at Denver, 1990.

David S. Herscovici, Visiting Assistant Professor (1992); PhD, Massachusetts Institute of Technology, 1992.

Toke Jayachandran, Professor (1967); PhD, Case Institute of Technology, 1967.

Wei Kang, Assistant Professor (1994); PhD, University of California at Davis, 1991.

David Mann, Visiting Assistant Professor (1993); PhD, Northeastern University, 1993.

Bard Mansager, Lecturer (1991); MA, University of California, San Diego, 1979.

Beny Neta, Professor (1985); PhD, Carnegie-Mellon University, 1977.

Guillermo Owen, Professor (1983); PhD, Princeton University, 1962.

Craig Rasmussen, Assistant Professor (1991); PhD, University of Colorado at Denver, 1990.

Ira Bert Russak, Associate Professor (1972); PhD, University of California at Los Angeles, 1967.

Chairman:

Richard H. Franke
Code MA/Fe, Glasgow
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Associate Chairmen:

Labs and Computing

Clyde Scandrett
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Research

Beny Neta
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Recruiting

Chris Frenzen
Associate Professor
Code MA/Fr, Glasgow
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DSN 878-2435

Academic Associate:

Maurice Weir
Professor
Code MA/Wc, Glasgow
Room 363
(408) 656-2608
DSN 878-2608

Clyde Scandrett, Associate Professor (1987); PhD, Northwestern University, 1985.

Arthur Schoenstadt, Professor and Associate Dean of Computer and Information Services (1970); PhD, Rensselaer Polytechnic Institute, 1968.

Maurice Dean Weir, Professor and Associate Dean of Instruction, (1969); DA, Carnegie-Mellon University, 1970.

* The year of joining the Naval Postgraduate School faculty is indicated in parentheses.

As well as the Master of Science and Ph.D. programs in Applied Mathematics, the Mathematics Department offers individually tailored minor programs for many of the school's doctoral students. The majority of the departmental effort is devoted to the service courses offered, including the refreshers and 1000-3000 level courses.

MASTER OF SCIENCE IN APPLIED MATHEMATICS

In order to enter a program leading to the degree Master of Science in Applied Mathematics, a student must be qualified by background for a Bachelor of Science degree with a major in mathematics or with a strong mathematical orientation in physical science or engineering.

A program that leads to the degree Master of Science in Applied Mathematics for a student who has met the entrance criteria must contain a minimum of 45-quarter hours of graduate-level courses with a minimum QPR of 3.0, subject to the following conditions:

- 1) The program must be approved by the Chairman of the Department of Mathematics and the Academic Associate.
- 2) The program must include at least fifteen hours at the 4000 level, with at least twelve hours in 4000 level mathematics courses.
- 3) The program must contain at least nine hours in an approved sequence of application courses from within the Mathematics Department, or outside the department.
- 4) An acceptable thesis is normally required and is credited as the equivalent of nine hours of 3000 level mathematics courses. A student receiving a dual masters and writing a thesis in another department may petition the Chairman of the Mathematics Department to substitute 2 or 3 approved courses for the thesis. The thesis, however, must contain a strong mathematical content.
- 5) Courses in the following areas are specifically required in any program; some of these courses may be used to satisfy part (or all) of the mathematics sequence requirement in item (3) above:
 - a. Real Analysis (a two-course sequence) and Modern Applied Algebra;
 - b. Ordinary and Partial Differential Equations;
 - c. Numerical Analysis;
 - d. Probability and Statistics;
 - e. Linear Algebra (a two-course sequence);
 - f. Mathematical Modeling Processes.

In addition to the core courses required in item (3), the program allows the student to select an applied subspecialty option from the following list: applied mathematics, numerical analysis and computation, discrete mathematics, operations research, theoretical mathematics, and intelligence.

DOCTOR OF PHILOSOPHY

The Department of Mathematics offers the degree Doctor of Philosophy in Applied Mathematics. Areas of specialization will be determined by the department on a case by case basis. Requirements for the degree include course work followed by an examination in both major and minor fields of study, and research culminating in an approved dissertation. It may be possible for the dissertation research to be conducted off-campus in the candidate's sponsoring organization.

Entrance into the program will ordinarily require a master's degree, although exceptionally well-prepared students with a bachelor's degree in mathematics may be admitted. A preliminary examination may be required to show evidence of acceptability as a doctoral student. Prospective students should contact the Chairman of the Mathematics Department or Academic Associate for further guidance.

COURSE SEQUENCES FOR SPECIAL CURRICULA

The Mathematics Department offers several sequences of courses for various curricula. Students of these curricula typically enter these sequences at their appropriate level and exit when completing their particular requirements.

COMPUTER SCIENCE

MA3025
MA3030

OPERATIONAL CURRICULA

MA2138
MA3139

ENGINEERING SCIENCE

MAR142 or MA1042
MAR117 or MA1117
MA1118
MA2049
MA2121
MA3132
MA3232

MANAGEMENT

MA2300

OPERATIONS RESEARCH

MAR142 or MA1042
MA1118
MA3042
MA3110

PREREQUISITES

Prerequisites are as described in the course descriptions. If a student has not taken the prescribed prerequisites at NPS, then a validation examination by the Mathematics Department may be substituted.

Generally speaking, credit for courses given in sequences will not be available to every student. Credit will be given for only one of a pair of equivalent courses.

COURSE OFFERINGS

MAR117 REFRESHER: SINGLE VARIABLE CALCULUS (NO CREDIT) (Meets last 6 weeks of quarter) (3-3). Single variable calculus review.

MAR118 REFRESHER: MULTIVARIABLE CALCULUS (NO CREDIT) (Meets last 6 weeks of quarter) (3-3). Multivariable calculus review.

MAR125 INTRODUCTION TO FINITE MATHEMATICS (NO CREDIT) (Meets last 6 weeks of quarter). (3-0).

An introduction to the elements of set theory and mathematical reasoning. Sets, Venn diagrams, truth tables, quantifiers, logical reasoning. Functions, relations, partitions and equivalence relations. 1-1 correspondence. Applications of finite mathematics such as finite difference equations, counting problems, geometric linear programming, and so forth are included.

MAR142 REFRESHER: MATRIX ALGEBRA (NO CREDIT) (Meets last six weeks of qtr) (2-0)

The fundamental algebra of matrices including addition, multiplication of matrices,

multiplication of a matrix by a constant and a column (vector) by a matrix. Elementary matrices and inverses, together with the properties of these operations. Solutions to $m \times n$ systems of linear algebraic equations are also investigated including Gaussian elimination and the LU decomposition of a matrix (without pivoting). Determinants, properties of determinants, and Cramer's rule for solving square systems; introduction to eigenvalues. A brief introduction to the arithmetic of complex numbers and DeMoivre's theorem.

MA0810 THESIS RESEARCH. (0-8).

Every student conducting thesis research will enroll in this course.

MA1042 MATRIX ALGEBRA (Also offered in Refresher mode as MAR142.) (2-0).

The fundamental algebra of matrices including addition, multiplication of matrices, multiplication of a matrix by a constant and a column (vector) by a matrix. Elementary matrices and inverses, together with the properties of these operations. Solutions to $m \times n$ systems of linear algebraic equations are also investigated including Gaussian elimination and the LU decomposition of a matrix (without pivoting). Determinants, properties of determinants, and Cramer's rule for solving square systems; introduction to eigenvalues. A brief introduction to the arithmetic of complex numbers and DeMoivre's theorem.

MA1043 INTENSIVE MATRIX ALGEBRA (2-0).

The fundamental algebra of vectors and matrices including addition, multiplication, and multiplication by a constant. Block operations with vectors and matrices. Algorithms for computing the LU (Gauss) factorization of an $n \times m$ matrix, with pivoting. Matrix representation of systems of linear equations and their solution via the LU factorization. The four fundamental subspaces. Basic properties of determinants. Matrix inverses. Introduction to eigenvalues. A brief introduction to the arithmetic of complex numbers and DeMoivre's theorem. COREQUISITE: EC1010.

MA1117 SINGLE VARIABLE CALCULUS. (5-2)

Review of analytic geometry and trigonometry, functions of one variable, limits, derivatives, continuity and differentiability; differentiation of algebraic, trigonometric, logarithmic and exponential functions with applications to maxima and minima, rates, differentials; product rule, quotient rule, chain rule; anti-derivatives, integrals and the fundamental theorem of calculus; definite integrals, areas, lengths of curves and physical applications; special methods of integration, including a 2 hour problem solving laboratory. PREREQUISITE: Precalculus mathematics.

MA1118 MULTI-VARIABLE CALCULUS. (5-2).

Vector algebra and calculus, directional derivative, gradient, polar coordinates and parametric equations, maxima and minima of functions of two independent variables, total differential; double and triple integrals, cylindrical and spherical coordinate systems; infinite series, convergence tests, and Taylor series, including a 2 hour problem solving laboratory. PREREQUISITE: Previous course in calculus.

MA1248 SELECTED TOPICS IN APPLIED MATHEMATICS FOR C3, SPACE OPERATIONS AND COMMUNICATIONS MANAGEMENT. (4-1).

A survey of selected calculus and post-calculus topics - infinite sequences and series; Fourier series and Fourier integral transforms; and matrix algebra and determinants. (This course may not be taken for credit by students in an engineering or science degree program). PREREQUISITE: MA1117.

MA2049 VECTOR ANALYSIS WITH APPLICATIONS (3-0).

Review of vector algebra. Bold and index notation. The calculus of vector fields; directional derivative, gradient divergence, curl; potential fields; Green's, Stokes', and the divergence integral theorem. Applications in engineering and physics. PREREQUISITE: MA1118 and MAR142 or MA1042.

MA2051 VECTORS AND COMPLEX VARIABLES (4-1)

Tentative course description: Review of vector algebra. The calculus of vector fields: gradient, divergence and curl. Potential fields. Green's, Stokes' and the Divergence theorems. Introduction to complex numbers. Differentiability and the Cauchy-Riemann conditions. Relation to Laplace's equation. Applications in engineering and physics. PREREQUISITES: MA1118 (or MAR118) and MA1042 (or MAR142).

MA2121 DIFFERENTIAL EQUATIONS. (4-0).

Ordinary differential equations: linear and nonlinear (first order) equations, homogeneous and non-homogeneous equations, linear independence of solutions, power series solutions, systems of differential equations, Laplace transforms. Applications include radioactive decay, elementary mechanics, mechanical and electrical oscillators, forced oscillations and resonance. PREREQUISITES: MA1118 or equivalent, MA1042 or equivalent, concurrently.

MA2138 SELECTED TOPICS FROM CALCULUS AND ORDINARY DIFFERENTIAL EQUATIONS. (5-0).

Partial derivatives, directional derivatives, tangent planes. Multiple integrals in rectangular, polar, cylindrical, and spherical coordinates. First order ordinary differential equations, second order linear equations with constant coefficients, Laplace transforms. Applications include filtering of electronic signals e.g., radar or sonar. For ASW and EW students only. PREREQUISITE: MA1117 or equivalent.

MA2300 MATHEMATICS FOR MANAGEMENT. (5-0).

Mathematical basis for modern managerial tools and techniques, with emphasis on military applications. Elements of differential and integral calculus. Introduction to matrix algebra and solutions of linear systems of algebraic equations. PREREQUISITE: College algebra.

MA3001 INCREMENTED DIRECTED STUDY. (1-0).

Provides the opportunity for a student who is enrolled in a 3000 level mathematics course to pursue the course material and its applications in greater depth by directed study to the extent of one additional hour beyond the normal course credit. PREREQUISITE: Enrollment in a 3000 level mathematics course and consent of instructor.

MA3002 INCREMENTED DIRECTED STUDY. (2-0).

Provides the opportunity for a student who is enrolled on a 3000 level mathematics course to pursue the course material and its applications in greater depth by directed study to the extent of two additional hours beyond the normal course credit. PREREQUISITE: Enrollment in a 3000 level mathematics course and consent of instructor.

MA3025 LOGIC AND DISCRETE MATHEMATICS (New course, replaces MA2025). (4-1)

MA3025 is designed to provide a rigorous foundation in logic and elementary discrete mathematics to students of mathematics and computer science. The emphasis is on logic and its application; the remaining mathematical topics are approached as a sequence of extensions to the predicate calculus. Topics from logic include textual substitution, Boolean expressions, modeling English propositions, and propositional calculus, quantification, and elementary predicate calculus. Additional mathematical topics include elements of set theory, induction, relations and functions, and elements of number theory.

MA3026 DISCRETE MATHEMATICS WITH APPLICATIONS (5-0).

Graphs, trees, matchings and network flows. Introduction to combinatorial problems and counting techniques. Recurrence relations. Combinatorial circuits and introduction to finite state machines. Applications to computer science. PREREQUISITE: MA2025.

MA3030 INTRODUCTION TO COMBINATORICS AND ITS APPLICATIONS (New course, replaces MA3026) (5-1).

MA3030 is designed to provide a thorough grounding in elementary combinatorics and its applications to computer science and discrete probability theory to students of computer science who concurrently take MA3025 Logic, Sets, and Functions. The course also extends and reinforces the coverage of predicate calculus from MA3025. Topics from combinatorics include fundamental counting rules, binomial and multinomial theorems, the pigeonhole and inclusion/exclusion principles, and homogeneous and nonhomogeneous recurrence relations. Elementary discrete probability is covered, up to the expectation of a discrete random variable. Coverage of predicate calculus is centered on the resolution principle and its applications. Also included is a brief introduction to algebraic structures. COREQUISITE: MA3025.

MA3042 LINEAR ALGEBRA (4-0).

Finite dimensional vector spaces, linear dependence, basis, dimension, inner products, orthogonalization. Linear transformations, rank and nullity, change of basis, least squares, QR factorizations, rank and singular value decomposition. Orthogonal transformations, symmetric matrices, diagonalization, eigenvalues and eigenvectors. PREREQUISITES: MA1118 taken concurrently, MA1042.

MA3046 MATRIX ANALYSIS (4-1).

Linear algebra from a constructive point of view, important for applications. Gauss and Cholesky factorizations. Orthogonalization, linear least squares problems and the fundamental theorem of linear algebra. Hermitian eigen problems and singular value decompositions. General eigen problems. Structured and inverse problems from signal analysis and control. PREREQUISITE: MA1043 or equivalent, or consent of instructor, familiarity with matlab.

MA3110 INTERMEDIATE ANALYSIS. (4-0).

Multi-variable calculus integrated with linear algebra. Functions of several variables, continuous transformations, Jacobians, chain rule, implicit function theorem, inverse function theorem, extrema, optimization and Lagrange multiplier technique. PREREQUISITE: MA1118 or equivalent, MA3042 or equivalent may be taken concurrently.

MA3132 PARTIAL DIFFERENTIAL EQUATIONS AND INTEGRAL TRANSFORMS. (4-0).

Solution of boundary value problems by separation of variables; Sturm-Liouville problems; Fourier, Bessel and Legendre series solutions, Fourier transforms; classification of second-order equations; applications, method of characteristics. Applications to engineering and physical science. Satisfies the ESR in differential equations for the applied mathematics programs. PREREQUISITE: MA2121 or equivalent.

MA3139 FOURIER ANALYSIS AND PARTIAL DIFFERENTIAL EQUATIONS. (4-0).

Fourier series; solution of the one and two-dimensional wave equations, D'Alembert's solution, frequency and time domain interpretations; Fourier integral transforms and applications to ordinary and partial differential equations and linear systems; Convolution theorems. Course covers basic material essential for signal processing, filtering, transmission, waveguides, and other related problems. Applications include spectral analysis of electronic signals, e.g. radar or sonar. For ASW and EW students. PREREQUISITE: MA2138.

MA3185 TENSOR ANALYSIS. (3-0).

Definition and algebra of tensors. Dyadic representation in Cartesian and general components. Calculus of tensor fields in curvilinear coordinates. Derivation and application of the basic equations of heat conduction, rigid body mechanics, elasticity, fluid mechanics, electromagnetism, Newtonian and Einsteinian orbital mechanics. PREREQUISITE: MA2049.

MA3232 NUMERICAL ANALYSIS. (4-1).

Provides the basic numerical tools for understanding more advanced numerical methods, including Finite Difference, Finite Element, and Boundary Element Methods. Topics for the course include: Solution of Nonlinear Equations, Interpolation, Numerical Integration and Differentiation, Numerical Solution of ODE's and BVP's, Numerical Linear Algebra and the Eigenvalue Problem, and Analysis of Computational Errors. PREREQUISITE: MA 2121 or equivalent (may be taken concurrently) and FORTRAN programming.

MA3243 NUMERICAL METHODS FOR PARTIAL DIFFERENTIAL EQUATIONS. (4-1).

Course designed to familiarize the student with classical finite difference techniques in the numerical solution of partial differential equations. In addition to learning some of the applicable algorithms, the student will be required to do some programming in FORTRAN. Topics covered include: Implicit, Explicit, and Semi-Implicit Methods in the solution of Elliptic and Parabolic PDE's, Iterative Methods for solving Elliptic PDE's (SOR, Gauss-Seidel, Jacobi), the Lax-Wendroff and Explicit methods in the solution of 1st and 2nd order Hyperbolic PDE's. PREREQUISITES: MA3132 and FORTRAN programming.

MA3261 BASIC PARALLEL COMPUTATION (3-0).

The course has two goals: First to introduce some fundamental issues: shared vs. distributed memory, connection topologies, communication algorithms, speedup, efficiency, storage requirements, granularity, pipelining, problem scaling, useful paradigms for algorithm development. Second, to develop working proficiency by designing, implementing and evaluating the performance of several parallel algorithms. These include, but are not limited to numerical quadrature, matrix computations, sorting, network analysis, and dynamic programming. PREREQUISITES: MA1118 or MA2025 and a computer language.

MA3301 LINEAR PROGRAMMING (Course taught by OR staff, same as OA3201). (4-1).

Theory of optimization of linear functions subject to linear constraints. The simplex algorithm, duality, sensitivity analyses, parametric linear programming. Applications to resource allocation, manpower planning, transportation and communications, network models, ship scheduling, etc. Introduction to computer-based linear programming systems. PREREQUISITES: MA3042, MA3110 and OA3200.

MA3393 TOPICS IN APPLIED MATHEMATICS (Variable hours 1-0 to 4-0).

A selection of topics in applied mathematics. The course content varies and the credit varies. This course is intended to reflect study for the beginning graduate student in an area for which no formal course is taught. Credit for this course may be granted more than one time to an individual student. PREREQUISITE: Consent of instructor.

MA3400 MATHEMATICAL MODELING PROCESSES. (4-0).

Practice model construction while demonstrating the utility and universality of mathematics. Topics include modeling using graphical analysis, the model building process, modeling using proportionality, analysis of data, modeling using dimensional analysis, dynamical models, optimization of models and simulation. Models investigated include the nuclear arms race, drag force on a submarine, optimization of inventory levels, and fuel consumption. PREREQUISITE: MA1118 or consent of instructor.

MA3560 MODERN APPLIED ALGEBRA. (3-0).

The techniques and tools of abstract algebra. Elements of set theory, equivalence relations and partitions. Semi-groups, groups, subgroups and homomorphisms. Ring, ideals and fields. Directed graphs and lattices. Applications may vary, but typically are drawn from topics of interest to DoN/DoD. These include error correcting codes, reliable and secure communications, cryptography, etc. Satisfies the algebra ESR PREREQUISITE: MA2042 or consent of instructor.

MA3605 FUNDAMENTALS OF ANALYSIS I. (3-0).

The real number system and the usual topology of the real line; properties of continuous functions; differentiation. Functions of bounded variation and theory of Riemann-Stieltjes integration, convergence theorems for sequence and series of functions. Satisfies the analysis ESR for the applied mathematics program. PREREQUISITE: MA3110 or consent of instructor.

MA3606 FUNDAMENTALS OF ANALYSIS II. (3-0).

Continuation of MA3605. PREREQUISITE: MA3605

MA3610 TOPOLOGY, FRACTALS, AND CHAOTIC DYNAMICS. (3-0).

An introductory course to fractals and chaotic dynamics utilizing techniques and ideas of metric space topology. Topics covered include: metric and topological spaces, completeness, the Hausdorff metric on the "space of fractals", affine transformations, iterated function systems, computer generation of fractals, dynamical systems, shift maps on code spaces, characterizations of chaotic dynamics, fractal dimension. Applications include feedback in predator-prey models, light emissions by cluster groups, photosynthesis, and electrical circuits. PREREQUISITE: MA1118 and MA2121.

MA3675 THEORY OF FUNCTIONS OF A COMPLEX VARIABLE I (3-0).

Selected topics from the theory of functions of a complex variable; complex functions, power series, Laurent series. Singularities of complex functions; contour integration and residues; zeros of analytic functions, factors of and infinite product representation for analytic functions; maximum modulus theorems for analytic and harmonic functions; conformal mapping. Applications include interference effects in optics and problems from heat flow and fluid flow. PREREQUISITE: MA1118 and consent of instructor.

MA3676 THEORY OF FUNCTIONS OF A COMPLEX VARIABLE II. (3-0).

Continuation of MA3675. PREREQUISITE: MA3675.

MA3730 THEORY OF NUMERICAL COMPUTATION. (3-0).

Analysis of computational methods used for the solution of problems from the areas of algebraic equations, polynomial approximation, numerical differentiation and integration, and numerical solutions of ordinary differential equations. PREREQUISITES: MA3042, MA2121 and consent of instructor.

MA4026 COMBINATORIAL MATHEMATICS (4-0).

Advanced techniques in enumerative combinatorics and an introduction to combinatorial structures. Topics include generating functions, recurrence relations, elements of Ramsey theory, theorems of Burnside and Polya, and balanced incomplete block designs. Application areas with DoD/DoN relevance range from mathematics to computer science and operations research, including applications in probability, game theory, network design, coding theory, and experimental design. PREREQUISITE: MA3025 or equivalent.

MA4027 GRAPH THEORY AND APPLICATIONS (4-0).

Advanced topics in the theory of graphs and digraphs. Topics include graph coloring, Eulerian and Hamiltonian graphs, perfect graphs, matching and covering, tournaments, and networks. Application areas with DoD/DoN relevance range from mathematics to computer science and operations research, including applications to coding theory, searching and sorting, resource allocation, and network design. PREREQUISITE: MA3025 or equivalent.

MA4101 INCREMENTED DIRECTED STUDY (1-0).

Provides the opportunity for the student enrolled in a 4000 level mathematics course to pursue the subject under faculty supervision to greater depth. One extra credit is assigned beyond the normal course credit. PREREQUISITE: Enrollment in a 4000 level math course and consent of instructor.

MA4102 INCREMENTED DIRECTED STUDY (2-0).

Provides the opportunity for the student enrolled in a 4000 level mathematics course to pursue the subject under faculty supervision to a greater depth. Two extra credits are assigned beyond the normal course credit. PREREQUISITE: Enrollment in a 4000 level math course and consent of instructor.

MA4103 THESIS TOPICS SEMINAR (3-0).

Explores in depth discrete dynamical systems and the thesis topics of students enrolled in the applied mathematics degree program. Fulfills the ESR to provide students with the experience of organizing and presenting applied mathematical ideas to students and faculty, including a classroom environment. PREREQUISITE: Consent of instructor. Graded on a Pass/Fail basis only.

MA4230 NUMERICAL FUNCTIONAL ANALYSIS. (3-0).

Linear functionals, Riesz representation theorem, Hilbert spaces, Sobolev spaces, interpolation and approximation in Hilbert spaces, nonlinear operators, Newton's method. PREREQUISITES: MA 3232, MA 4635.

MA4237 ADVANCED TOPICS IN NUMERICAL ANALYSIS (Variable credit usually 4-0) (V-0).

The subject matter will vary according to the abilities and interest of those enrolled. Applications of the subject matter to DoD/DoN are discussed. PREREQUISITE: Consent of instructor.

MA4242 NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS (3-1).

Adams formulas, Runge-Kutta formulas, extrapolation methods, implicit formulas for stiff equations; convergence and stability, error estimation and control, order and stepsize selection, applications. PREREQUISITE: MA3232.

MA4243 NUMERICAL SOLUTION OF PARTIAL DIFFERENTIAL EQUATIONS (3-1).

Finite difference methods for parabolic, elliptic, and hyperbolic equations, multi-grid methods; convergence and stability, error estimation and control, numerical solution of finite difference equations, applications. PREREQUISITES: MA3232, MA3132, MA4230 suggested.

MA4245 MATHEMATICAL FOUNDATIONS OF FINITE ELEMENTS (3-1).

Variational formulation of boundary value problems, finite element and boundary element approximations, types of elements, stability, eigenvalue problems. PREREQUISITES: MA3232, MA3132.

MA4248 COMPUTATIONAL LINEAR ALGEBRA (4-1).

Development of algorithms for matrix computations. Rounding errors and introduction to stability analysis. Stable algorithms for solving systems of linear equations, linear least squares problems and eigen problems. Iterative methods for linear systems. Structured problems from applications in various disciplines. PREREQUISITES: MA3042 or equivalent, or consent of instructor, advanced matlab programming.

MA4251 APPLIED APPROXIMATION THEORY (3-1).

Univariate and tensor product spline approximation, interpolation in Hilbert spaces, scattered data approximation, applications. PREREQUISITES: MA3232, MA4230.

MA4261 DISTRIBUTED SCIENTIFIC COMPUTING. (3-2)

General principles of parallel computing, parallel techniques and algorithms, solution of systems of linear equations, eigenvalues and singular value decomposition, domain decomposition and application (e.g., satellite orbit determination and shallow water fluid flow). PREREQUISITES: MA3042 or MA3046, MA3132, and MA3232.

MA4301 NONLINEAR PROGRAMMING (Course taught by OR staff, same as OA4201). (4-0).

Introduction to modern optimization techniques, Karush-Kuhn-Tucker necessary and sufficient conditions for optimality, quadratic and separable programming, basic gradient search algorithms and penalty function methods. Applications to weapons assignment, force structuring, parameter estimation for nonlinear or constrained regression, personnel assignment and resource allocation. PREREQUISITES: OA3201 and MA3110.

MA4302 DESIGN OF EXPERIMENTS (Course taught by OR staff, same as OA4101). (3-1).

Theory and application of the general linear hypothesis model. Analysis of variance and analysis of covariance. Planning experiments, traditional and hybrid experimental designs. Use of standard computer packages for analysis of experimental data. PREREQUISITE: OA3103 or equivalent.

MA4303 REGRESSION ANALYSIS. (Course taught by OR staff, same as OA4102) (4-0).

Construction, analysis and testing of regression models. An in-depth study of regression and its application in operations research, economics and the social sciences. PREREQUISITES: OA3102, OA3103 and OA3104.

MA4304 TIME SERIES ANALYSIS (Course taught by OR staff, same as OA4308.) (4-0).

Second order stationary processes. Harmonic analysis of correlation functions. Filters and spectral windows. Ergodic properties. Problems of inference in time series analysis. Box-Jenkins techniques. Introduction to the analysis of multivariate processes. PREREQUISITES: OA3301 and OA3104.

MA4311 CALCULUS OF VARIATIONS (3-0).

Euler equation, Weierstrass condition, Legendre condition, numerical procedures for determining solutions, gradient method, Newton method, Transversality condition, Rayleigh Ritz method, conjugate points. Concepts are related to geometric principles wherever possible. PREREQUISITE: MA2121 (programming experience desirable).

MA4312 TOPICS IN CALCULUS OF VARIATIONS (3-0).

Topics covering extensions of concepts presented in MA4311. PREREQUISITE: MA4311 and computer programming.

MA4321 STABILITY, BIFURCATION AND CHAOS (3-0).

Differential equations and dynamical systems, equilibrium of autonomous systems, stability, Liapunov's method, examples of chaos, local bifurcations of vector fields and maps, chaotic dynamical systems. PREREQUISITE: MA4620.

MA4322 PRINCIPLES AND TECHNIQUES OF APPLIED MATHEMATICS I

(3-0). Linear operators, generalized functions and Hilbert spaces; solutions of partial differential equations by Green's functions and eigenfunctions; variational techniques; Fredholm and Volterra integral equations; asymptotic methods and perturbations. Applications to wave propagation, optimization, fluid dynamics, and numerical methods. PREREQUISITE: MA3132 and MA3042 or equivalent.

MA4323 PRINCIPLES AND TECHNIQUES OF APPLIED MATHEMATICS II (3-0). Continuation of MA4322. PREREQUISITE: MA4322.

MA4332 PARTIAL DIFFERENTIAL EQUATIONS (3-0).

Diffusion, wave and Laplace equations. Classification of second order equations, discontinuities and signal propagation, transform methods, Green's functions, first order equations and characteristics. PREREQUISITE: MA3132.

MA4335 LINEAR AND NONLINEAR WAVES (3-0).

Analysis of the two main classes of wave motion, hyperbolic waves and linear dispersive waves. Topics covered include: kinematic waves, shock waves, shock structure and shock fitting, Burger's equation, the wave equation, linear dispersive waves, wave patterns and water waves. PREREQUISITE: MA3132.

MA4340 ADVANCED MATHEMATICAL MODELING (3-0).

A course intended to bring advanced mathematical methods to bear on the modeling and study of physical problems. Topics to be discussed include: simple dynamic models, the phase plane, stable and unstable motion, wave motion, bifurcation, catastrophe and chaos. PREREQUISITES: MA3400 and MA3132.

MA4362 ORBITAL MECHANICS. (3-0).

Review of the two-body problem. The effects of a third point mass and Codes used by the military to predict the orbits of artificial satellites and space debris. PREREQUISITE: Consent of instructor.

MA4372 INTEGRAL TRANSFORMS (3-0).

The Laplace, Fourier and Hankel transforms and their inversions; Asymptotic behavior. Applications to problems in engineering and physics. PREREQUISITE: Consent of instructor

MA4377 ASYMPTOTIC AND PERTURBATION METHODS I (3-0).

Advanced course in the application of approximate methods to the study of integrals and differential equations arising in physical problems. Topics covered include: asymptotic sequences and expansions, integrals of a real variable, contour integrals, limit process expansions applied to ordinary differential equations, multiple variable expansion procedures and applications to partial differential equations. PREREQUISITE: MA3132.

MA4378 ASYMPTOTIC AND PERTURBATION METHODS II (3-0).

Advanced course in the application of approximate methods to the study of integrals and differential equations arising in physical problems. Topics covered include: asymptotic sequences and expansions, integrals of a real variable, contour integrals, limit process expansions applied to ordinary differential equations, multiple variable expansion procedures and applications to partial differential equations. PREREQUISITE: MA4377.

MA4391 ANALYTICAL METHODS FOR FLUID DYNAMICS (4-0).

The basic fluid dynamic equations will be derived, and a variety of analytical methods will be applied to problems in viscous flow, potential flow, boundary layers, and turbulence. Applications in aeronautics will be discussed. PREREQUISITE: MA3132 or MA3139 or consent of instructor.

MA4392 NUMERICAL METHODS FOR FLUID DYNAMICS (4-0).

Numerical methods exclusively will be applied to fluid dynamics problems in viscous flow, potential flow, boundary layers, and turbulence. Applications in aeronautics will be discussed. PREREQUISITE: MA4391 and MA3232 or consent of instructor.

MA4393 TOPICS IN APPLIED MATHEMATICS. (3-0).

A selection of topics in applied mathematics. The course content varies but applications of interest to the DoN/DoD will be discussed. Credit may be granted for taking this course more than once. PREREQUISITE: Consent of instructor.

MA4399 DISSERTATION RESEARCH (Variable credit).**MA4560 CODING AND INFORMATION THEORY (4-0).**

Mathematical analysis of the codes used over communication channels is made. Techniques developed for efficient, reliable and secure communication are stressed.

Effects of noise on information transmission are analyzed and techniques to combat their effects are developed. Linear codes, finite fields, single and multiple error-correcting codes are discussed. Codes have numerous applications for communication in the military, and these will be addressed. PREREQUISITE: MA3560.

MA4565 ADVANCED MODERN ALGEBRA (3-0).

A continuation of MA3560. Rings, ring homomorphism, integral domains and euclidean domains. Unique factorization rings, polynomial rings. Modules and ideals. Noetherian rings, Field extension and Galois theory PREREQUISITE: MA3560, or consent of instructor.

MA4570 CRYPTOGRAPHY (4-0).

The methods of secret communication are addressed. Some simple crypto systems are described and classical techniques of substitution and transposition are considered. The public-key crypto systems, RSA, Discrete Logarithm and other schemes are introduced. Applications of cryptography and crypto analysis. PREREQUISITE: MA3560.

MA4593 TOPICS IN ALGEBRA. (3-0).

A selection of topics in algebra. Content of the course varies. Credit for taking the course more than once is allowed. Students may select a topic of interest to the DoN/DoD, so the course can support the MER's in a variety of curricula. PREREQUISITE: MA3560 or consent of instructor.

MA4595 MATHEMATICAL FOUNDATIONS OF FAST SIGNAL PROCESSING ALGORITHMS (3-0).

Advanced transform algorithms for signal processing. Generalized Cooley-Tukey, Rader prime factor, and Winograd FFT algorithms. Polynomial rings, the Chinese Remainder theorem for polynomials, quotient fields, and reduced multiplication convolution algorithms. Application to hardware and software design for signal processing systems PREREQUISITE: EC3400 or equivalent.

MA4620 THEORY OF ORDINARY DIFFERENTIAL EQUATIONS. (3-0).

Introduction to the modern theory of ordinary differential equations. Systems of equations. Theoretical and constructive methods of solutions. PREREQUISITES: MA2121 and MA3042.

MA4635 FUNCTIONS OF REAL VARIABLES I (3-0).

Semi-continuous functions, absolutely continuous functions, functions of bounded variation; classical Lebesgue measure and integration theory, convergence theorems and L_p spaces. Abstract measure and integration theory, signed measures, Radon-Nikodym theorem; Lebesgue decomposition and product measure; Daniell integrals and integral representation of linear functionals. PREREQUISITE: MA3606.

MA4636 FUNCTIONS OF REAL VARIABLES II. (3-0).

Continuation of MA4635. PREREQUISITE: MA4635.

MA4675 COMPLEX ANALYSIS (3-0).

A continuation of MA3675, MA3676. Differential equations in the complex plane, transform methods, the Weiner-Hopf method, integral equations, discrete Fourier analysis. PREREQUISITES: MA3675, MA3676.

MA4693 TOPICS IN ANALYSIS. (3-0).

A selection of topics in analysis. Content of the course varies. Students will be allowed credit for taking the course more than once. PREREQUISITE: Consent of instructor.

DEPARTMENT OF MECHANICAL ENGINEERING

Chairman:

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Associate Chairmen:

Operations:

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Young Sik Shin
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Charles N. Calvano, Associate Professor (1991)*; Ocean Engineer, Massachusetts Institute of Technology, 1970.

Roy Crooks, Research Associate Professor (1990); PhD, Georgia Institute of Technology, 1982.

Morris Driels, Professor (1989); PhD, City University, London, 1973.

Indranath Dutta, Associate Professor (1988); PhD, University of Texas, Austin, 1988.

Francis B. Fassnacht, Senior Lecturer (1991); BSEE Union College, 1951.

Alan G. Fox, Associate Professor (1989); PhD, University of Birmingham, United Kingdom, 1982.

Ashok Gopinath, Assistant Professor (1994); PhD, University of California, Los Angeles, 1992.

Joshua H. Gordis, Assistant Professor (1992); PhD, Rensselaer Polytechnique Institute, 1990.

David R. Gordon, LCDR, Military Instructor (1993); MS, Naval Postgraduate School, 1991.

Anthony Healey, Professor (1986); PhD, Sheffield University, United Kingdom, 1966.

Matthew Dennis Kelleher, Chairman and Professor (1967); PhD, University of Notre Dame, 1966.

Joung Kook Kim, Research Assistant (1992); MS, University of Illinois, 1985.

Atul Kumar, Research Assistant (1994); PhD, University of Cambridge, United Kingdom, 1994.

Young W. Kwon, Associate Professor (1990); PhD, Rice University, 1985.

Paul James Marto, Dean of Research, Distinguished Professor (1965); ScD, Massachusetts Institute of Technology, 1965.

Terry Robert McNelley, Professor (1976); PhD, Stanford University, 1973.

Sarath Kumar Menon, Research Assistant Professor (1994); PhD Carnegie Mellon University, 1985.

Knox Taylor Millsaps, Jr., Assistant Professor (1992); PhD, Massachusetts Institute of Technology, 1992.

Ranjan Mukherjee, Assistant Professor (1991), PhD, University of California, Santa Barbara, 1989.

Fotis A. Papoulias, Associate Professor (1988), PhD, University of Michigan, 1987.

Arthur J. Perkins, Professor (1972); PhD, Case Western Reserve University, 1969.

Paul Francis Pucci, Emeritus Professor (1956) PhD, Stanford University, 1955.

Jon D. Raggett, Senior Lecturer (1992); PhD, Princeton University, 1971.

Dean A. Rains, Senior Lecturer (1993); PhD California Institute of Technology, 1954.

David Salinas, Emeritus Associate Professor (1970); PhD, University of California, Los Angeles, 1968.

Turgut Sarpkaya, Distinguished Professor (1967); PhD, University of Iowa, 1954.

Isaac Shai, Visiting Professor (1993); PhD, Massachusetts Institute of Technology, 1967.

Young Sik Shin, Professor (1981); PhD, Case Western Reserve University, 1971.

* The year of joining the Naval Postgraduate School faculty is indicated in parentheses.

The department of Mechanical Engineering provides a strong academic program which spans across the discipline areas of structural mechanics, dynamics and control, materials science and the thermal-fluid sciences. These disciplines are blended together with an emphasis on naval engineering applications such as may be experienced on surface vessels and in submarines.

Programs leading to the degree Master of Science in Mechanical Engineering are accredited at the advanced level by the Engineering Accreditation Commission of the Accreditation Board for Engineering and Technology.

A specific curriculum must be consistent with the general minimum requirements for the degree as determined by the Academic Council.

Any program leading to award of a degree must be approved by the Chairman of the Department of Mechanical Engineering at least two quarters before completion. In general, approved programs will require more than minimum degree requirements in order to conform to the needs and objectives of the United States Navy.

MASTER OF SCIENCE IN MECHANICAL ENGINEERING

A candidate shall have completed work equivalent to the Bachelor of Science requirements of this department. Candidates who have not majored in Mechanical Engineering, or who have experienced a significant lapse in continuity with previous academic work, initially will take undergraduate courses in mechanical engineering and mathematics in preparation for their graduate program.

The candidate must take all courses in a curriculum approved by the Chairman of the Department of Mechanical Engineering. At minimum, the approved curriculum must satisfy the requirements below.

The Master of Science degree in Mechanical Engineering requires at least 32 quarter hours of graduate level credits in Mechanical Engineering and Materials Science, at least 12 of which must be at the 4000 level. In addition, at least 8 quarter hours of graduate credit must be earned outside of Mechanical Engineering and Materials Science. Officers specializing in Materials Science must have their selection of electives approved by the Chairman.

An acceptable thesis is required for the Master of Science in Mechanical Engineering degree. An acceptable thesis for the degree of Mechanical Engineer may also be accepted as meeting the thesis requirement for the master's degree. Approval of the thesis advisor and topic must be obtained from the Chairman of the Department of Mechanical Engineering.

MASTER OF SCIENCE IN ENGINEERING SCIENCE

Students with acceptable academic backgrounds may enter a program leading to the degree Master of Science in Engineering Science (with major in Mechanical Engineering).

The program must include at least 36 credit hours of graduate work in the disciplines of engineering, science and mathematics, 12 of which must be at the 4000 level. Of those 36 hours, at least 20 hours (eight of which must be at the 4000 level) must be in Mechanical Engineering and Materials Science. In addition, the program must contain at least 12 hours at the graduate level in courses outside Mechanical Engineering and Materials Science.

The student seeking the degree Master of Science in Engineering Science must submit an acceptable thesis. Programs leading to this degree must be approved by the Chairman of the Department of Mechanical Engineering.

MASTER OF SCIENCE IN MATERIALS SCIENCE AND ENGINEERING

Students with acceptable backgrounds in science or engineering may enter a program leading to the degree Master of Science in Materials Science and Engineering. The candidate must take all courses in a curriculum approved by the Chairman of the Department of Mechanical Engineering and the faculty member designated to represent the Materials Science program. At a minimum, the approved curriculum must satisfy the requirements listed below.

MECHANICAL ENGINEER

A graduate student with a superior academic record (with a graduate QPR of 3.70 or better) may enter a program leading to the degree Mechanical Engineer. A candidate is normally selected after completion of his first year of residence.

A candidate must take all courses in a curriculum approved by the Chairman of the Department of Mechanical Engineering. At minimum, the approved curriculum must satisfy the requirements stated in the following paragraphs.

The Mechanical Engineer degree requires at least 60 quarter hours of graduate level credits in Mechanical Engineering and Materials Science, at least 30 of which must be at the 4000 level. In addition, at least 12 quarter hours of graduate level credits must be earned outside of Mechanical Engineering and Materials Science.

An acceptable thesis is required for the Mechanical Engineer degree. Approval of the thesis advisor and program must be obtained from the Chairman of the Department of Mechanical Engineering.

TOTAL SHIP SYSTEMS ENGINEERING PROGRAM

A Mechanical Engineer degree may also be obtained as part of the Total Ship Systems Engineering program. The program objective is to provide a broad-based design-oriented education focusing on the warship as a total engineering system. Entry requirements are a baccalaureate degree in an engineering discipline with an APC of 222 and students are expected to validate several courses in the standard MSME degree program. A thesis is required that may address system design issues. The advisor and topic must have prior approval of the Chairman of the Mechanical Engineering Department.

DOCTOR OF PHILOSOPHY AND DOCTOR OF ENGINEERING

The Department of Mechanical Engineering has an active program leading to the degrees of Doctor of Philosophy and Doctor of Engineering. Areas of special strength in the department are hydrodynamics, viscous flows, heat transfer, materials science, dynamics and control, vibrations and finite element analysis and computer aided design.

Entrance into the doctoral program may be requested by officers currently enrolled

who have sufficiently high standing. A departmental screening examination will be administered to those so requesting. The department also accepts officer students selected in the Navy-wide doctoral study program and civilian students selected from employees of the United States Federal Government.

All applicants who are not already enrolled as students in the Department of Mechanical Engineering shall submit transcripts of their previous academic and professional records and letters of recommendation to the department Chairman. The Chairman, with the advice of other department members, shall decide whether or not to admit the applicant to the doctoral program.

Every applicant who is accepted for the doctoral program will initially be enrolled in the Mechanical Engineering Program under a special option which satisfies the broad departmental requirements for the Engineer's degree and which includes research work. As soon as feasible, the student must find a faculty advisor to supervise research and help initially in the formulation of plans for advanced study. As early as practicable thereafter, a doctoral committee shall be appointed to oversee that student's individual doctoral program as provided in the school-wide requirements for the doctor's degree. Joint programs with other departments are possible. A noteworthy feature of the program leading to the Doctor of Engineering degree is that the student's research may be conducted away from the Naval Postgraduate School in a cooperating laboratory or other installations of the Federal Government. The degree requirements are as outlined in the general school requirements for the doctor's degree.

LABORATORIES

The Mechanical Engineering Laboratories are designed as complements to the educational mission and research interests of the department. In addition to extensive facilities for the support of student and faculty research, a variety of general use equipment is available. This includes machinery for the investigation of dynamic and statistics problems in engineering mechanics; a completely equipped materials science laboratory, including a scanning electron microscope, a transmission electron microscope and an X-ray diffractometer; an oscillating water tunnel, a unique underwater towing tank and a low turbulence water channel; a vibration analysis laboratory; a fluid power controls laboratory; a robotics and real-time control laboratory; facilities for experimentation with low velocity air flows; equipment for instruction in thermal transport phenomena; a laser doppler velocimeter; nuclear radiation detection equipment and an interactive CAD/CAE computer graphics laboratory. Experimentation is further enhanced by a broad selection of analog and digital data acquisition and processing equipment and instrumentation.

COURSE OFFERINGS

ME0810 THESIS RESEARCH (0-8).

Every student conducting thesis research will enroll in this course.

ME0951 SEMINARS (NO CREDIT) (0-1).

Lectures on subjects of current interest are presented by NPS faculty and invited experts from other universities and government and industrial activities.

ME1000 PREPARATION FOR PROFESSIONAL ENGINEERS REGISTRATION

(3-0). The course will cover the topics from the 8 hour Professional Examination given by the State of California for Professional Engineers. Discussion will involve applicable engineering techniques, including design and analysis of mechanical systems and components. **PREREQUISITE:** Prior passage of EIT Exam or consent of instructor. Graded on Pass/Fail basis only.

ME2001 INTRODUCTION TO ENGINEERING (3-0).

The origins of engineering. The role of mathematics and the physical sciences in engineering. Definition of an engineering problem, including its formulation, assumptions and method of attack. Engineering analysis. The engineering design process. Engineering communications, including graphics. This course is intended for

students with a non-engineering background. PREREQUISITE: MA1117 (may be taken concurrently).

ME2101 ENGINEERING THERMODYNAMICS (4-1).

A comprehensive coverage of the fundamental concepts of classical thermodynamics, with insight toward microscopic phenomena. The laws of thermodynamics. Equations of state. Thermodynamic properties of substances. Entropy, irreversibility and availability. Cycle analysis. Gas-vapor mixtures. Combustion and dissociation.

PREREQUISITE: MA1118.

ME2201 INTRODUCTION TO FLUID MECHANICS (3-2).

Properties of fluids, hydrostatics and stability of floating and submerged bodies. Fluid flow concepts and basic equations in steady flows: mass, momentum and energy considerations. Dimensional analysis and dynamic similitude. Viscous effects and fluid resistance. Drag and separated flow over simple bluff bodies. PREREQUISITE: ME2502.

ME2440 THE DIGITAL COMPUTER AS AN ENGINEERING TOOL (3-0).

Introduction to high-level programming languages including FORTRAN and BASIC. Development of computer programs, subroutine organization, input and output. Application of programming techniques to the solution of selected problems in Mechanical Engineering. PREREQUISITES: MA1118, ME2101, ME2501 (all may be taken concurrently), ME2441 (must be taken concurrently).

ME2441 ENGINEERING COMPUTATIONAL LABORATORY (0-2).

Introduction to the computing facilities at the Naval Postgraduate School with particular emphasis on those unique to the Department of Mechanical Engineering. Familiarization with software available at the Naval Postgraduate School for solution of engineering problems. Various programming exercises. (ME2440 must be taken concurrently). Graded on a Pass/Fail basis only.

ME2501 STATICS (3-0).

Forces and moments, particles and rigid bodies in equilibrium. Simple structures, friction, first moments and centroids. PREREQUISITE: MA1118 (may be concurrent).

ME2502 DYNAMICS (4-1).

Kinematics and kinetics of particles and rigid bodies. Rectilinear, plane curvilinear and space curvilinear motion. Newton's laws, work and energy, impulse and momentum and impact. Plane motion of rigid bodies and introduction to gyroscopic motion.

PREREQUISITE: ME2501.

ME2601 MECHANICS OF SOLIDS I (3-2).

Stress-strain. Hookes Law. Plane stress and plane strain. Stress transformation for plane stress. Mohr's circle. Principal stresses and axes. Stress analysis of bars, circular shafts, cylindrical and spherical thin walled pressure vessels. Shear and bending diagrams for beams. Stresses in beams. Failure theories. Torsion of thin walled closed tubes. Composite beams. Euler columns. Supporting laboratory work.

PREREQUISITES: ME2501 and MA1118 or equivalent.

ME2801 INTRODUCTION TO ENGINEERING SYSTEM DYNAMICS (3-2).

Generalized system modeling principles and reduction to mathematical forms. Analogies between electrical, mechanical, fluid and thermal systems. Response of first and second order systems characteristics, transient response. PREREQUISITES: ME2502 and MA2121.

ME3150 HEAT TRANSFER (4-1).

Introduction to the various modes of heat transfer and their engineering applications. Steady and unsteady conduction involving the use of thermal circuit analogs, analytical, finite difference and graphical techniques. Introduction to conservation of mass, momentum and energy. External and internal forced convection fundamentals and correlations. External natural convection. Boiling. Condensation. Heat exchanger

analysis. Thermal radiation. PREREQUISITES: ME2101, ME2201, MA3132 (may be taken concurrently).

ME3201 INTERMEDIATE FLUID MECHANICS (3-2).

Steady one-dimensional compressible flow. Fundamentals of ideal-fluid flow, potential function, stream function. Analysis of viscous flows, velocity distribution in laminar and turbulent flows, introduction to the elements of the Navier-Stokes equations, solution of classical viscous laminar flow problems. Boundary layer concepts. PREREQUISITES: ME2101, ME2201, MA3132 (may be taken concurrently).

ME3220 STEAM POWER, REFRIGERATION AND TURBOMACHINERY (3-2).

The conventional Rankine cycle steam plants, including superheat, reheat and regenerative cycles. Boiler, condenser and feed-water heater description. Thermodynamics of refrigeration systems. Fundamentals of turbomachinery: energy and momentum equations, dimensional analysis and velocity diagrams. Blade design and work determination from blade shape. Application to pumps, fans, compressors and turbines. PREREQUISITES: ME2101 and ME2201.

ME3230 NUCLEAR POWER SYSTEMS (3-1).

Introduction to atomic and nuclear physics. Fundamentals of nuclear reactor analysis, including nuclear and thermal aspects in core design. Reactor system design and operation. Comparison of principal reactor types emphasizing significant features of marine reactors. Basic health physics considerations and reactor shielding. Basic insight into waste management and reactor safety. PREREQUISITE: MA3132.

ME3240 RECIPROCATING AND GAS TURBINE POWER PLANTS (3-0).

Thermodynamic analysis and performance characteristics of single and multi-stage reciprocating air compressors, spark ignition engines (Otto Cycle), compression ignition engines (diesel cycle) and gas turbine engines (Brayton cycle). Gas turbine component characteristics including the aerodynamics of the compressor and turbine design and the combustor. Ship propulsion requirements, propeller characteristics and Ship/Propeller/Power Plant matching. PREREQUISITES: ME2101, ME2201, (ME3241 must be taken concurrently).

ME3241 POWER PLANTS LABORATORY (0-3).

Selected experiments demonstrating power plant performance, e.g., diesel engine and gas turbine engine. (ME3240 must be taken concurrently.) Graded on Pass/Fail basis only.

ME3410 MECHANICAL ENGINEERING INSTRUMENTATION AND MEASUREMENT LAB (2-4).

Introduction to measurement systems, statistical analysis of data, error analysis, uncertainty analysis, manipulation of data including electrical readout and processing, data acquisition fundamentals. Measurement of temperature, pressure, velocity, flow rates. Energy balances, surface temperature visualization, flow visualization. Measurement of motion using accelerometers and encoders. Measurement of strain and force. Operational amplifiers, analog computers, filters. PREREQUISITES: ME2601, ME2801, ME3521, ME3150 (ME3150 and ME3521 may be taken concurrently).

ME3440 ENGINEERING ANALYSIS (4-0).

Rigorous formulation of engineering problems arising in a variety of disciplines. Approximate methods of solution. Finite Difference methods. Introduction to finite Element methods. PREREQUISITES: ME2201, ME2440, ME2502 and ME2601.

ME3521 MECHANICAL VIBRATION (3-2).

Free and forced vibration of discrete linear systems. Vibration isolation and suppression. Vibration of bars, shafts and beams. Supporting laboratory work. PREREQUISITES: ME2502, ME2601 and MA2401 or equivalent (may be taken concurrently).

ME3611 MECHANICS OF SOLIDS II (4-0).

Differential equations of bars, shafts and beams with Macauley functions. Unsymmetric bending. Curved beams. Shear flow in thin walled sections. Shear center. Torsion of thin walled open sections. Thick walled cylinders. Energy including Castigliano and unit dummy load methods for displacements. Statically indeterminate systems including beams, frames, trusses, arches and combined structures. PREREQUISITE: MA2047 or MA2089

ME3711 DESIGN OF MACHINE ELEMENTS (4-1).

Design of representative machine elements with consideration given to materials selection, tolerances, stress concentrations, fatigue, factors of safety, reliability and maintainability. Typical elements to be designed include fastener, columns, shafts, journal bearings, spur and helical gears and clutches and brakes. In addition to traditional design using factors of safety against failure, particular emphasis is placed on design for specified reliability using probabilistic design methods. PREREQUISITE: ME2601.

ME3801 LINEAR AUTOMATIC CONTROL (3-0).

Classical control design for linear systems with single input, single output design requirements. PID control. Transient response analysis. Root locus and frequency response methods. Control design and compensation techniques. PREREQUISITE: ME2801. ME3802 must be taken concurrently.

ME3802 CONTROLS LABORATORY (0-2).

Adjunct laboratory for ME3801. Must be taken concurrently with ME3801.

ME3950 SURFACE SHIP SURVIVABILITY (4-0).

Surface ship survivability requirements and lessons learned in combat; radar cross section reduction by shaping and RAM; IR missile detection and tracking; electronic counter measures for decoying and jamming missiles. Assessment of ship survivability and implementation of trade-off studies. Case study of DDG-51 survivability design. PREREQUISITES: Consent of instructor and department Chairman.

ME4160 APPLICATIONS OF HEAT TRANSFER (4-0).

Applications of heat transfer principles to engineering systems. Topics include heat exchangers (e.g., boilers, condensers, coolers), cooling electronic components, heat pipes, solar collectors, turbine blade cooling. PREREQUISITE: ME3150.

ME4161 CONDUCTION HEAT TRANSFER (4-0).

Steady-state heat conduction in multi-dimensions with and without heat sources. Transient conduction. Numerical methods for heat conduction. Mechanical Engineering applications. PREREQUISITE: ME3150.

ME4162 CONVECTION HEAT TRANSFER (4-0).

Fundamental principles of forced and free convection. Laminar and turbulent duct flows and external flows. Dimensionless correlations. Heat transfer during phase changes. Heat exchanger analysis with Mechanical Engineering applications. PREREQUISITES: ME3150, ME4220.

ME4163 RADIATION HEAT TRANSFER (3-0).

Basic laws and definitions. Radiation properties of surfaces. Radiant interchange among diffusely emitting and reflecting surfaces. Applications and solutions of the equations of radiant interchange. Radiant interchange through participating media. Combined conduction and radiation. PREREQUISITE: ME3150.

ME4202 COMPRESSIBLE FLOW (3-0).

Review of simple one-dimensional flow. Generalized one-dimensional flow. Two-dimensional and axisymmetric flows. Subsonic flow with small perturbations. Mach lines. Methods of characteristics. Prandtl-Meyer expansion waves. Oblique shocks. Unsteady, one-dimensional flow. Introduction to compressible boundary layer. PREREQUISITE: ME3201 or equivalent compressible flow coverage.

ME4211 APPLIED HYDRODYNAMICS (4-0).

Fundamental principles of hydrodynamics. Brief review of the equations of motion and types of fluid motion. Standard potential flows: source, sink, doublet and vortex motion. Flow about two-dimensional bodies. Flow about axisymmetric bodies. Added mass of various bodies and the added-mass moment of inertia. Complex variables approach to flow about two-dimensional bodies. Conformal transformations. Flow about hydro and aerofoils. Special topics such as dynamic response of submerged bodies, hydroelastic oscillations, etc. Course emphasizes the use of various numerical techniques and the relationship between the predictions of hydrodynamics and viscous flow methods. PREREQUISITE: ME3201.

ME4220 VISCOUS FLOW (4-0).

Development of continuity and Navier-Stokes equations. Exact solutions of steady and unsteady viscous flow problems. Development of the boundary-layer equations. Similarity variables, numerical and integral techniques. Separation, boundary-layer control, compressibility effects. Time-dependent boundary layers. Origin and nature of turbulence, phenomenological theories, calculation of turbulent flows with emphasis on naval engineering applications. PREREQUISITE: ME3201.

ME4240 ADVANCED TOPICS IN FLUID DYNAMICS (4-0).

Topics selected in accordance with the current interests of the students and faculty. Examples include fluid-structure interactions, cable strumming, wave forces on structures, free-streamline analysis of jets, wakes and cavities. PREREQUISITES: ME4220 and ME4211.

ME4420 MARINE GAS TURBINES (4-0).

Thermodynamic analyses of gas turbine cycles, including airbreathing and closed cycle engines. Internal aerodynamics of compressor and turbine design. Combustor and source heat exchanger design. Materials considerations. Operational controls and instrumentation. Lubrication and fuels systems. Inlet, exhaust and silencing systems. Propulsion of surface effect, hydrofoil and conventional surface ships. Installation arrangements. Waste heat recovery systems and combined cycles (COGAS, CODOG). Auxiliary power generation. Repair and maintenance. PREREQUISITE: ME3240.

ME4522 SHIPBOARD VIBRATION AND NOISE (4-0).

Mechanical impedance, transfer matrices and their application to transmission of vibratory motion from machinery sources to hull plating. Acoustic signal generation at the hull-fluid interface. Characteristics of viscoelastic materials and their use in vibration isolation. Multi-isolator mounts. Study of accordion and flexural vibration of ship hulls using one-dimensional finite element modeling. Military vibration specifications. Use of vibration measurements for machinery condition monitoring. PREREQUISITE: ME3521.

ME4525 NAVAL SHIP SHOCK DESIGN AND ANALYSIS (4-0).

Characteristics of underwater explosion phenomena, including the shock wave, bubble behavior and bubble pulse loading and bulk cavitation. Surface ship/submarine bodily response to shock loading. Application of shock spectra to component design. Dynamic Design Analysis Method (DDAM) and applications to shipboard equipment design. Fluid-Structure Interaction (FSI) analysis, including Doubly Asymptotic Approximation (DAA) and surface ship FSI. Current design requirements for shipboard equipment. PREREQUISITE: ME3521 or equivalent.

ME4550 RANDOM VIBRATIONS AND SPECTRAL ANALYSIS (3-2).

Engineering application of spectral analysis techniques to characterize system responses under a random vibration environment. Characteristics of physical random data and physical system responses. Application of probability concepts to random data and response analysis. Correlation and spectral density functions. Transmission of random vibration. System responses to single/multiple random excitations. Failure due to random vibration. Supporting laboratory work. PREREQUISITE: ME3521 or equivalent.

ME4612 ADVANCED MECHANICS OF SOLIDS (4-0).

Selected topics from advanced strength of materials, elasticity and the theory of plates and shells. Applications of finite element codes to the solution of difficult problems.

PREREQUISITE: ME3611.

ME4613 FINITE ELEMENT METHODS (4-0).

Systematic construction of line, surface and volume elements for continuous systems. Computer programming and applications to structural mechanics, heat transfer and fluid flow. PREREQUISITE: ME3611.

ME4620 THEORY OF CONTINUOUS MEDIA (4-0).

Tensor analysis. Stress and strain tensors. Motion of continuum. Energy and entropy. Constitutive equations. Applications to elasticity and fluid dynamics.

PREREQUISITES: ME3201 and ME3611.

ME4721 MARINE VEHICLE DESIGN (2-4).

Various categories of marine vehicles are described; this includes single hull, multiple hull, submarine, surface effect, wing-in-ground effect and hydrofoil vehicles. A category of marine vehicle is selected to fulfill a stated mission. A vehicle configuration and specification of major facets of marine vehicle synthesis including structures, hull forces, propulsion, electronics, armament, crew, etc. PREREQUISITE: Consent of instructor.

ME4722 MARINE ENGINEERING DESIGN (2-4).

A major component of a marine vehicle is designed so as to meet stated specifications. Impact of the design features of the major component upon the overall vehicle performance is considered; emphasis is on design tradeoffs. Examples of major components to be designed include complete electrical power generation and distribution systems, steering, superconducting electrical motors for main propulsion, bulbous bow for sonar, armor protection of CIC, etc. PREREQUISITE: Consent of instructor.

ME4731 ENGINEERING DESIGN OPTIMIZATION (4-0).

Application of automated numerical optimization techniques to design of engineering systems. Algorithms for solution of nonlinear constrained design problems. Familiarization with available design optimization programs. State-of-the-art applications. Solution of a variety of design problems in mechanical engineering, using numerical optimization techniques. PREREQUISITES: ME3150, ME3201, ME3611, ME2440, MA2400, or equivalent.

ME4811 MODERN CONTROL SYSTEMS (3-2).

Multivariable analysis and control concepts for MIMO systems. State Observers. Linear Optimal Control. Introduction to non-linear systems analysis. Limit cycle behavior.

PREREQUISITE: ME3801.

ME4812 FLUID POWER CONTROL (3-0).

Fluids and fluid flows in high-performance actuators and controllers. Power flow and fluid power elements - valve and pump control, linear and rotary motion. State space descriptions. Design of electro-hydraulic position and velocity control servo-mechanisms for high performance with stability. ME4813 must be taken concurrently. PREREQUISITE: ME3801.

ME4813 FLUID POWER LABORATORY (0-2).

Adjunct laboratory course for ME4812. Must be taken concurrently with ME4812.

ME4821 ADVANCED DYNAMICS (3-2).

Introduction to the variational principle. Kinematics and dynamics of three-dimensional motion for complex systems utilizing Newton-Euler's method, Lagrange's method and Kane's method. Computer software implementation and simulation.

Applications in robotics emphasizing the dynamic problems of design and control. PREREQUISITE: ME3521.

ME4823 DYNAMICS OF MARINE VEHICLES (4-0).

Development of the nonlinear equations of motion in ship-fixed coordinates. Linear forms. Elements of pathkeeping and stability for ships and submersibles. Maneuverability. Hydrodynamic aspects of hull propulsor and appurtenances. Design tools for estimating hydrodynamic derivatives and their effects on vehicle performance. Selected topics. PREREQUISITE: ME3201.

ME4825 MARINE PROPULSION CONTROL (3-2).

Introduction to dynamic propulsion systems modeling and analysis methods. Control design specifications and design strategies. Introduction to modern control design theory and multivariable methods. Theory and applications of optimal control and discrete-time control systems. Case studies of current Naval propulsion control systems. PREREQUISITES: ME3801, ME3240 (may be taken concurrently) and MA3132.

ME4902 ADVANCED STUDY IN MECHANICAL ENGINEERING (Variable hours 1-0 to 6-0) (V-0).

Directed advanced study in mechanical engineering on a subject of mutual interest to student and staff member after most of a student's electives have already been taken. May be repeated for credit with a different topic. PREREQUISITE: Permission of department Chairman. Graded on Pass/Fail basis only.

MS0810 THESIS RESEARCH (0-8).

Every student conducting thesis research will enroll in this course.

MS2201 INTRODUCTION TO ENGINEERING MATERIALS (3-2).

The basic principles of materials science are covered with emphasis on the factors involved in control of the physical and mechanical properties of materials used in Naval systems. Atomic and crystal structure are discussed and emphasis is given to microstructural control and microstructure-property relationships. Additional topics include crystalline defects, deformation processes, strengthening mechanisms and heat treatment. The course aims to provide the student with the working vocabulary and conceptual understanding necessary more advanced study and for communication with materials experts. PREREQUISITES: Undergraduate courses in physics and chemistry and consent of instructor.

MS3202 PROPERTIES, PROBLEMS AND FAILURES OF MATERIALS (3-2).

Properties, problems and failures of structural materials are studied in the context of actual case studies. Topics of interest to Naval, Aero and Combat Systems Engineers are included. For a given case study, the cause(s) of failure are discussed and the relevant fundamental knowledge to fully understand the observed phenomena is developed. Failure prevention, materials developments and modern methods of materials analysis are among the many aspects that are of interest. PREREQUISITE: MS2201 or equivalent or consent of instructor.

MS3304 CORROSION AND MARINE ENVIRONMENTAL DEGRADATION (3-2).

Presents the basic chemical, electrochemical, mechanical and metallurgical factors which influence the corrosion, oxidation and deterioration of materials. Discusses standard methods of corrosion control, such as cathodic protection coatings, cladding, alloy selection and inhibitors; special problems encountered in unfamiliar environment. PREREQUISITE: MS2201 or equivalent.

MS3505 MATERIALS SELECTION FOR MILITARY APPLICATIONS (4-0).

This course deals in-depth with one of the most common and important problems in materials engineering, that of selecting the optimum material for a given application. Consideration is also given to evolution of new applications for existing materials and to materials development for new and old applications. A variety of application areas are covered, including marine structures, aerospace applications, nuclear reactors, electronics, high temperature cryogenic services and many other situations. Sources of information, methodology and basic rationale for materials selection decisions are presented. Emphasis is put on the variation in properties of a given material with processing history and on variation of properties in service. PREREQUISITE: MS2201 or equivalent.

MS3606 INTRODUCTION TO WELDING AND JOINING METALLURGY (3-2).

Welding and joining are presented from the point of view of metallurgy. Topics include the nature and applications of welding and joining processes; the welding thermal cycle; metallurgical effects of the welding thermal cycle; welding and joining of steels, aluminum alloys, stainless steels and heat resistant alloys. Also, weldment inspection and quality assurance are introduced. PREREQUISITES: MS2201/MS3201.

MS4215 PHASE TRANSFORMATIONS (3-2).

Structural changes which commonly occur in materials by various mechanisms are considered. Solidification, precipitation, recrystallization and martensitic transformations are emphasized, both in principle and in regard to their technological importance. Principles of nucleation and growth, diffusion and kinetics are presented and their relevance to practical heat treating and fabrication processes are considered. PREREQUISITE: MS2201 or equivalent.

MS4312 CHARACTERIZATION OF ADVANCED MATERIALS (3-2).

The course is structured to provide insight into the various tools available for advanced physical examination of engineering materials. Topics covered include x-ray diffraction, and optical, scanning, transmission and scanning transmission electron microscopies. PREREQUISITES: MS2201, MS3202 or equivalent.

MS4811 MECHANICAL BEHAVIOR OF ENGINEERING MATERIALS (4-0).

The response of structural materials to mechanical stress is discussed with emphasis on plastic deformation in metals. Topics include elastic response and the modulus of elasticity; plasticity; deformation mechanisms and dislocation theory; strengthening mechanisms; and fatigue and fracture. Application of subject to materials development is also considered. PREREQUISITE: MS3202 or permission of instructor.

MS4822 THE ENGINEERING AND SCIENCE OF COMPOSITE MATERIALS (4-0).

This course focuses on the structure-property correlation in composites utilizing a multi-disciplinary approach, covering the areas of materials science and engineering and solid mechanics. Emphasis is given to the theoretical constitutive behavior at the micro- and macro-levels, as well as on how such behavior can be altered by processing and service variables. The course is divided into three broad parts: (1) Theoretical predictions of composite properties; (2) Materials issues (including processing) complicating accurate performance prediction; and (3) Thermo-mechanical behavior in actual service conditions. PREREQUISITES: ME3611, MS3202 or equivalent.

MS4902 SPECIAL TOPICS IN MATERIALS SCIENCE (Variable hours 1-0 to 6-0)

Directed advanced study in materials science on a subject of mutual interest to student and staff member after the student has taken most of his or her electives. May be repeated for credit with a different topic. PREREQUISITE: Permission of department Chairman. Graded on Pass/Fail basis only.

TS3000 ELECTRICAL POWER ENGINEERING (3-2).

An overview of the principles, concepts and trade-offs which form the foundation for shipboard electric power systems. The composition of electrical power systems for present and future Navy vessels is presented. Theory necessary to understand interactions among shipboard electric power system components is discussed. The interactions between the electric power system and the various types of loads is introduced. PREREQUISITE: EC2270 or EC2110.

TS3001 FUNDAMENTAL PRINCIPLES OF NAVAL ARCHITECTURE (3-2).

The geometry, hydrostatics and hydrodynamics of monohull and other floating and submerged bodies; Froude similarity; wave and skin friction resistance; powering determination. Longitudinal and transverse stability of floating bodies. Hull girder strength. Introduction to seakeeping and passive survivability principles. PREREQUISITES: ME2201 and ME2601.

TS3002 PRINCIPLES OF SHIP DESIGN AND CASE STUDIES (3-2).

Systems engineering in the design of complex systems; systems architecture and interface engineering and the Navy design environment. The systems development process, including need identification, requirements, feasibility determination, risk reduction, contract and detailed design. The iterative, multi-level ship design process, with affordability as a fundamental feature; modern ship design and construction methods. Case studies, ship design trends, design exercises and illustrative problems. PREREQUISITE: TS3001.

TS3003 NAVAL COMBAT SYSTEM ELEMENTS (3-2).

This course will cover combat system detection and engagement elements. This includes radar, ESM, active and passive sonar, infrared, warheads, guns, missiles, torpedoes, fire control and countermeasures. The emphasis will be on what the elements contribute to a combat system, their basic principles of operation, their performance limitations, and their interfaces with the rest of the combat system. Details on the internal functioning of specific elements will be limited to illustrating applications of basic principles and interactions affecting system engineering. PREREQUISITES: MA2049, ME2502, EC2170 or equivalent. SECRET clearance.

TS4000 NAVAL COMBAT SYSTEM ENGINEERING (3-2).

This course will cover the definition and integration of Naval combat systems. The emphasis will be on how the various detection, engagement, and control elements interact with each other and on how to combine them into an efficient and survivable combat system. Also addressed will be topside arrangements, signature reduction, readiness assessment, embedded training, real time computer programs, and support system interfaces. Details on specific elements and systems will be limited to those needed to illustrate basic principles and methods. PREREQUISITES: TS3003, TS3000. SECRET clearance required.

TS4001 INTEGRATION OF NAVAL ENGINEERING SYSTEMS (4-1).

A systems-oriented approach to integrating the principles of Naval Architecture, Marine Engineering and Materials Engineering in the design of mechanical ship subsystems. Lectures and projects exploring engineering design tools and project management techniques used to meet specified systems requirements. Materials issues affecting ship design. Group projects on hull, mechanical and electrical ship systems design. The impact of systems design on other systems and subsystems, including affordability and survivability at the whole ship level are considered. PREREQUISITES: TS3000, TS3002 and MS3201.

TS4002 SHIP DESIGN INTEGRATION (2-4).

The ship impact of requirements/cost/performance tradeoffs within technical and acquisition constraints. Conversion of broad military requirements to mission-based ship requirements and specific tasks resulting from those requirements. Exploration of alternative methods of satisfying requirements, leading to combat systems (payload) definition. Conduct of feasibility studies to investigate whole-ship alternatives which meet requirements. Selection of a best design approach. Special design aspects of, aircraft carriers and variable payload ships. Design considerations for unusual ship types and an assessment of future Navy ship and combat systems needs and trends. PREREQUISITES: TS4001 and TS4000. SECRET clearance required.

TS4003 TOTAL SHIP SYSTEMS ENGINEERING (2-4).

The design of a Naval vessel as a single engineering system satisfying mission requirements, with emphasis on affordability and survivability. The interaction and interfacing of various subsystems such as hull, propulsion and combat systems will be explored through a joint ship "preliminary design" project to produce a balanced ship design based on the alternative chosen from feasibility studies conducted in TS4002. Concepts of design optimization within constraints. PREREQUISITES: TS4002 and SECRET clearance required.

DEPARTMENT OF METEOROLOGY

Lester E. Carr, Lieutenant Commander, U.S. Navy; Assistant Professor (1992)*; PhD, Naval Postgraduate School, 1989.

Chih-Pei Chang, Professor (1972); PhD, University of Washington, 1972.

Jeng-Ming Chen, Research Assistant Professor (1989); PhD, University of California at Los Angeles, 1989.

Kenneth L. Davidson, Professor (1970); PhD, University of Michigan, 1970.

Philip A. Durkee, Associate Professor (1984); PhD, Colorado State University, 1984.

Russell L. Elsberry, Professor (1968); PhD, Colorado State University, 1968.

George W. Haltiner, Distinguished Professor Emeritus (1946); PhD, University of Wisconsin, 1948.

Robert L. Haney, Chairman and Professor (1970); PhD, University of California at Los Angeles, 1971.

Patrick A. Harr, Research Assistant Professor (1989); MS, Colorado State University, 1978; PhD Naval Postgraduate School, 1993.

Paul A. Hirschberg, Research Assistant Professor (1990); PhD, Pennsylvania State University, 1989.

Bao-Fong Jeng, Research Assistant (1993); MS, National Taiwan University, 1986.

Frank L. Martin, Professor Emeritus (1947); PhD, University of Chicago, 1941.

James T. Murphree, Research Assistant Professor (1991); PhD, University of California at Davis, 1989.

Wendell A. Nuss, Associate Professor (1986); PhD, University of Washington, 1986.

Patricia A. Pauley, Research Associate Professor (1990); PhD, Purdue University, 1985.

Melinda S. Peng, Research Associate Professor (1984); PhD, State University of New York at Albany, 1982.

Robert J. Renard, Distinguished Professor Emeritus (1952); PhD, Florida State University, 1970.

Willem van der Bijl, Professor Emeritus (1961); PhD, State University, Utrecht, 1952.

Pom Sirayanone, National Research Council Postdoctoral Associate (1993); PhD, Iowa State University, 1988.

Alvaro Viudez, Postdoctoral Research Associate (1995); PhD, Universitat de les Illes Balears, 1994.

Carlyle H. Wash, Professor (1980); PhD, University of Wisconsin, 1978.

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Roger T. Williams
Professor
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Room 247
(408) 656-2296
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Forrest R. Williams, Senior Lecturer (1983); MS, Massachusetts Institute of Technology, 1972.

Roger T. Williams, Professor (1968); PhD, University of California at Los Angeles, 1963.

* The year of joining the Naval Postgraduate School faculty is indicated in parentheses.

The Department of Meteorology is one of eleven departments and its history dates back to the 1940s when it was part of the Postgraduate Department at the Naval Academy. The department's academic function is interdisciplinary in nature in that it supports separate Master of Science Degree programs: Meteorology, Meteorology and Physical Oceanography, and Oceanography; and, provides courses for the Space, Antisubmarine Warfare, Electronic Warfare, and Command, Control and Communications (C3) curricula.

Department academic strengths include air/ocean dynamics and numerical modeling and prediction, structure and dynamics of the atmospheric boundary layer, satellite remote sensing and its applications and synoptic meteorology, including analysis and prediction in tropical, middle latitude and polar regions in both hemispheres. More than forty courses are offered in meteorology, primarily at the graduate level. The department has twenty-two faculty (8 tenure-track, 9 non-tenure-track, 1 military, and 4 emeritus), with graduate student participation as research-team members through the MS thesis and Ph.D. dissertation process. The current areas of research concentration encompass numerical and analytic air/ocean modeling and prediction, tropical meteorology, including monsoon circulations and tropical cyclone forecasting, coastal meteorology, climate dynamics, marine boundary layer studies with emphasis on air/sea interactions and electromagnetic/optic propagation, remote sensing/satellite meteorology and a wide range of synoptic studies (e.g., regional studies, maritime cyclogenesis, short range forecasting, numerical-model verification).

Both Visiting Scientist and Navy-sponsored Research Chair programs are an integral part of the department's operation. The Ph.D. program in the department is active with Navy Officers, Air Force Officers, DoD civilians and internationals among its recent graduates.

DEPARTMENT REQUIREMENTS FOR DEGREES

MASTER OF SCIENCE IN METEOROLOGY

Entrance to a program leading to a Master of Science degree in Meteorology requires a baccalaureate degree with completion of mathematics through differential and integral calculus and a minimum of one year of college physics.

The degree Master of Science in Meteorology requires completion of:

- 1) Necessary prerequisite courses in mathematics (through partial differential equations) and meteorology,
- 2) The sequence of core courses in the fields of dynamical, numerical, physical and synoptic meteorology,
- 3) An approved selection of graduate elective courses,
- 4) An acceptable thesis.

The total number of quarter hours in (2) and (3) above must be at least 36. These 36 hours must include 18 quarter hours at the 4000 level in courses other than directed study.

MASTER OF SCIENCE IN METEOROLOGY AND PHYSICAL OCEANOGRAPHY

Direct entrance to a program leading to the degree Master of Science in Meteorology and Physical Oceanography requires a baccalaureate degree in one of the physical sciences, mathematics or engineering. This normally permits the validation of a number of required undergraduate courses such as physics, differential equations, linear algebra, vector analysis and various courses in meteorology and/or oceanography which are prerequisites to the graduate program. These prerequisites may be taken at the Naval Postgraduate School; however, in that event the program may be lengthened by one or more quarters.

The degree Master of Science in Meteorology and Physical Oceanography requires completion of:

- 1) Necessary prerequisite courses in mathematics (through partial differential equations), meteorology and physical oceanography,
- 2) The sequence of core courses in the fields of dynamical, numerical, physical and synoptic meteorology and oceanography,
- 3) An approved selection of graduate elective courses in meteorology and oceanography,
- 4) An acceptable thesis on a topic approved by either department.

The total number of quarter hours in (2) and (3) above must be at least 48. These 48 hours must include 20 hours at the 4000 level in courses other than directed study and they should show an approximate balance between the disciplines of meteorology and physical oceanography.

DOCTOR OF PHILOSOPHY

The Ph.D. program is offered in the Department of Meteorology in the following areas of study: numerical weather prediction, geophysical fluid dynamics, boundary-layer meteorology, analysis of atmospheric systems and tropical meteorology.

The requirements for the degree are grouped into three categories: course work, research in conjunction with an approved dissertation and examination in both the major and a minor field. The minor field is usually in physical oceanography, mathematics or physics.

The Department of Meteorology also may require a preliminary examination to show evidence of acceptability as a doctoral student.

Prospective students should consult with the Chairman of the Department of Meteorology for further guidance regarding doctoral programs.

LABORATORIES

As described below, the Department is served by four major laboratory facilities: An interactive computer lab, a synoptic meteorology lab, a meteorological measurements lab and a tactical applications lab.

The Interactive Digital Environmental Analysis (IDEA) Laboratory, which is shared with Oceanography, provides real-time acquisition and analysis of conventional and remotely-sensed data in support of the synoptic and physical meteorology and oceanography programs. The laboratory consists of 16 image analysis and graphics workstations and more than 20 gigabytes of disk storage. The laboratory accesses real-time GOES, NOAA, Navy (FNOC), and DMSP data for use in instruction and research.

The department has developed a modern Synoptic Analysis and Forecasting Laboratory which receives products and observations for instruction on the preparation of real-time

weather analyses and forecasts. Fleet Numerical Oceanographic Center weather analysis and forecast products are received via the Navy Oceanographic Data Distribution System (NODDS) and National Weather Service analyses and forecasts are received via PC-based DIFAX facsimile systems and UNIDATE internet distribution. Satellite imagery can be animated with a PC-based digital satellite image processing system connected to GOESTAP. Current weather observations are accessible through the COMEDS and a RADAC Weather Radar Receiver. Level II NEXRAD data will be available through a PUP station in FY 95. The unique combination of Navy and civilian weather observations and products available in the lab provide students with the opportunity to examine and forecast the weather over the entire world.

The Marine Atmospheric Measurements Laboratory utilizes in-situ and remote sensing instrumentation systems for both teaching and research. Instrumentation includes: 915 MHz Doppler radar wind profiler with radio acoustic sounding system (RASS); rawinsonde systems with Omega and LORAN navigational aids; three-axis monostatic SODAR; and fully instrumented surfaced weather station. A Navy Automated Surface Observing System (ASOS) is scheduled to be delivered during FY 95. Access to other instrumentation (measuring turbulent fluxes, aerosols, etc.), measuring platforms (research vessel, buoys and remotely piloted aircraft) and data from a variety of networked local measurement sites enables the laboratory to provide near "real-time" data from the coastal region. Calibration facilities include a temperature/humidity calibration chamber and access to a wind tunnel.

The department also has a Joint Tactical Laboratory designed to assist students in applying and testing in an operational setting the oceanographic and meteorological principles learned in the classroom. The Joint Tactical Laboratory is a classified lab equipped with the same Receiver units used aboard aircraft carriers, permitting real-time access and manipulation of environmental data and satellite imagery. The Joint Tactical Laboratory also has eight computer workstations that run full suite of Geophysical Fleet Mission Planning Library (GF MPL) programs used by Navy oceanographers to facilitate analysis and forecasting in support of fleet operations. The lab supports a number of classified research projects, and theses, in addition for classroom instruction.

COURSE OFFERINGS

MR2210 REFRESHER, INTRODUCTION TO METEOROLOGY/LAB (NO CREDIT).

Same as MR2210 except taught during the refresher period (last six weeks of the quarter). **PREREQUISITE:** Department approval.

MR0810 THESIS RESEARCH (0-8).

Every student conducting thesis research will enroll in this course.

MR0999 SEMINAR IN METEOROLOGY (NO CREDIT). (2-0).

Students present results of thesis or other approved research investigation.

PREREQUISITE: Concurrent preparation of thesis or other acceptable research paper.

MR2020 COMPUTER COMPUTATIONS IN AIR-OCEAN SCIENCES (1-2).

Introduction to FORTRAN and NPS mainframe computer as applied to elementary problems in oceanography and meteorology. **PREREQUISITES:** Calculus and college physics.

MR2200 INTRODUCTION TO METEOROLOGY (4-0).

An introductory course that treats the composition and structure of the atmosphere, thermodynamic processes, forces and related small- and large-scale motions, air masses, fronts, severe storms, solar and terrestrial radiation, general circulation and weather forecasting. **PREREQUISITE:** Department approval.

MR2210 INTRODUCTION TO METEOROLOGY/LABORATORY (4-2).

Same course as MR2200 plus laboratory periods illustrating lecture material, including

Navy Operational Global Atmospheric Prediction System (NOGAPS) analysis over oceanic areas, plus satellite imagery interpretation. PREREQUISITE: Department approval.

MR2262 ELEMENTS OF WEATHER FORECASTING (1-2).

Survey of subjective and objective methods of atmospheric prognosis. Weather briefings illustrate applications of forecasting principles and use of satellite imagery. PREREQUISITES: MR3222, MR3230 or consent of instructor.

MR2413 METEOROLOGY OF ANTISUBMARINE WARFARE (3-1).

Atmospheric factors affecting the air-sea interface, and the marine atmospheric boundary layer; local and synoptic-scale atmospheric features relevant to electromagnetic and electro-optical wave propagation; hands-on experience with existing environmental effects assessment models. PREREQUISITES: Differential and integral calculus (may be taken concurrently).

MR2416 METEOROLOGY FOR ELECTRONIC WARFARE (2-0).

A survey of environmental factors affecting the propagation and attenuation of electromagnetic waves. Synoptic and climatological conditions associated with anomalous refraction are studied. Ionospheric phenomena associated with longer wavelength (Hf) propagation. Layers associated with high aerosol concentration and optical turbulence are identified. Hands-on experience with existing environmental effects assessment models. PREREQUISITES: Differential and integral calculus. (May be taken concurrently).

MR2419 ATMOSPHERIC FACTORS IN C3 (2-0).

A survey of atmospheric properties and processes affecting propagation of electromagnetic (EM) and electro-optical (EO) waves. Tropospheric phenomena associated with standard and anomalous EM wave propagation at wavelengths greater than 10 meters. Ionospheric phenomena associated with larger wavelength (Hf) propagation. PREREQUISITE: Enrollment in C3 curriculum.

MR2520 SURVEY OF AIR-OCEAN REMOTE SENSING (3-0).

Overview of systems for remote sensing of the atmosphere and oceans from space, and operational applications. PREREQUISITES: Undergraduate physics and calculus, or consent of instructor.

MR3140 PROBABILITY AND STATISTICS FOR AIR-OCEAN SCIENCE (3-2).

Basic probability and statistics, in the air-ocean science context. Techniques of statistical data analysis. Structure of a probability model, density distribution function, expectation and variance. Binomial, Poisson and Gaussian distributions. Conditional probability and independence. Joint distributions, covariance and central limit theorem. Transformations of random variables. Histograms and empirical distributions and associated characteristics such as moments and percentiles. Standard tests of hypotheses and confidence intervals for both one-and two-parameter situations. Regression analysis as related to least squares estimation. PREREQUISITE: Calculus.

MR3150 ANALYSIS OF AIR/OCEAN TIME SERIES (3-2). Analysis methods for atmospheric and oceanic time series. Fourier transforms applied to linear systems and discrete data. Correlation functions, power density spectra and cospectra. Optimal design of air-ocean data networks. Laboratory work involves analysis of actual atmospheric and oceanic time series using principles developed in class. PREREQUISITES: MA3132 and a probability and statistics course.

MR3212 POLAR METEOROLOGY/OCEANOGRAPHY (4-0).

Operational aspects of arctic and antarctic meteorology. Polar oceanography. Sea-ice; amount, its seasonal distribution, melting and freezing processes, physical and mechanical properties, drift and predictions. PREREQUISITES: OC3240, MR3222 or consent of instructor.

MR3220 METEOROLOGICAL ANALYSIS (4-0).

Techniques of evaluation, interpretation and analysis of pressure, wind, temperature and moisture data, including weather satellite observations, with emphasis on the low and middle troposphere. Synoptic models of extratropical vortices, waves and frontal systems, with emphasis on three dimensional space structure and time continuity, including isentropic surfaces and vertical cross-section analysis. Introduction to analysis in the high troposphere and low stratosphere, including daily exposure to Navy Operational Global Atmospheric Prediction System (NOGAPS) analysis.
PREREQUISITES: MR3420, MR/OC3321.

MR3222 METEOROLOGICAL ANALYSIS/LABORATORY (4-3).

Same as MR3220 plus laboratory sessions on the concepts considered in the lectures, with emphasis on the analysis of the low and middle troposphere, streamline and isotach analysis techniques, satellite interpretation, and vertical cross-section analysis.
PREREQUISITES: MR3420, MR/OC3321.

MR3230 TROPOSPHERIC AND STRATOSPHERIC METEOROLOGY (4-0).

Development and application of conceptual models of the evolution of various tropospheric and stratospheric circulation systems. Extratropical cyclones, jet streams and fronts are examined through application of dynamical concepts with particular emphasis on aspects associated with the marine environment. PREREQUISITES: MR3222; MR4322 (may be concurrent).

MR3234 TROPOSPHERIC AND STRATOSPHERIC METEOROLOGY/LABORATORY (4-4).

Same as MR3230 plus laboratory sessions utilizing the IDEA Lab to facilitate the physical understanding of dynamic relationships inherent to the conceptual models of the various weather systems. Exercises utilize various case studies including material from recent marine cyclogenesis field experiments. PREREQUISITES: MR3222; MR4322 (may be concurrent).

MR3240 RADAR METEOROLOGY (3-0).

Principles of radar meteorology. Topics covered include radar systems, meteorological radar equation, doppler radar basics, propagation, attenuation, precipitation and velocity estimation, and characteristic echoes. PREREQUISITES: MR3222 and MR3522.

MR3250 TROPICAL METEOROLOGY (3-0).

Structure and mechanisms of synoptic-scale wave disturbances, cloud clusters, upper-tropospheric systems, the intertropical convergence zone; structure, development and motion of tropical cyclones; monsoon circulations. Emphasis on analysis and energetics. PREREQUISITES: MR4322 and MR3230 or MR3234 (may be concurrent).

MR3252 TROPICAL METEOROLOGY/LABORATORY (3-4).

Same as MR3250 plus laboratory sessions on analysis of tropical systems emphasizing streamline and isotach analysis and incorporating aircraft and satellite observations. Exercises stress tropical cyclone regimes. Satellite imagery is used as an analysis tool and also in forecasting tropical cyclone intensity. A track forecasting exercise provides an exposure to the use of various dynamic, climatological and statistical forecast models. PREREQUISITES: MR4322 and MR3230 or MR3234 (may be concurrent).

MR3260 OPERATIONAL ATMOSPHERIC PREDICTION (3-0).

Subjective and objective methods of atmospheric prognosis and techniques for forecasting operationally-important weather elements from surface to 100 mb. Interpretation, use and systematic errors of computer-generated products. Weather satellite briefs and applications of forecasting principles to current situations. PREREQUISITES: MR3230, or MR3234; MR/OC4323 (may be concurrent).

MR3262 OPERATIONAL ATMOSPHERIC PREDICTION/LABORATORY (3-5).

Same as MR3260 plus laboratory sessions on the application of lecture material. Also, practice in weather briefing, including diagnosis and forecasting of current weather situations using weather satellite observations, and Fleet Numerical Oceanography

Center and National Meteorological Center products. PREREQUISITES: MR3230 or MR3234; MR/OC4323 (may be concurrent).

MR3321 AIR-OCEAN FLUID DYNAMICS (4-0).

A foundation course for studies of atmospheric and oceanographic motions. The governing dynamical equations for rotating stratified fluids are derived from fundamental physical laws. Topics include: the continuum hypothesis, real and apparent forces, derivations and applications of the governing equations, coordinate systems, scale analysis, simple balanced flows, boundary conditions, thermal wind, barotropic and baroclinic conditions, circulation, vorticity, and divergence. PREREQUISITE: MA2047.

MR3420 ATMOSPHERIC THERMODYNAMICS (3-0).

Topics to be covered include: the physical variables, the equation of state, the first law of thermodynamics and its application to the atmosphere, meteorological thermodynamic diagrams, adiabatic processes and potential temperatures, moist air processes, hydrostatic equilibrium, vertical motion in the atmosphere, stability methods and criteria. PREREQUISITE: MA1116 or equivalent.

MR3421 CLOUD PHYSICS (3-0).

Basic principles of cloud and precipitation physics and application to weather modification. Selected topics in atmospheric pollution. PREREQUISITE: MR3420.

MR3445 OCEANIC AND ATMOSPHERIC OBSERVATIONAL SYSTEMS (2-2).

Principles of measurement: sensors, data acquisition systems, calibration, etc. Methods of measurement for thermodynamic and dynamic variables in the ocean and atmosphere including acoustics and optics. PREREQUISITES: OC3230 and MR3420, MR/OC3150 or consent of instructor.

MR3455 MEASUREMENT SYSTEMS FOR THE MARINE AND COASTAL ATMOSPHERIC BOUNDARY LAYER (2-2).

The course treats a broad spectrum of measurement techniques for atmospheric dynamic and thermodynamic variables. Laboratory sessions provide hands-on experience with various state-of-the-art sensing systems, including NPS's new Doppler Radar Wind Profiler. Topics include sensor static and dynamic characteristics; calibration; in situ measurements of wind, pressure, temperature, humidity and radiation on the surface, on balloon-borne sounding systems and on aircraft; and surface-based remote sensing systems, including wind profilers, SODAR and LIDAR. PREREQUISITES: MR3222 and MR3150 or consent of the instructor.

MR3480 ATMOSPHERIC THERMODYNAMICS AND RADIATIVE PROCESSES (4-1).

Topics to be covered include: the physical variables, the equation of state, the first law of thermodynamics and its application to the atmosphere, meteorological thermodynamic diagrams, adiabatic processes and potential temperatures, moist air processes, hydrostatic equilibrium, vertical motion in the atmosphere, stability methods and criteria. Basic solar and terrestrial radiation theory; atmospheric energy budgets; climate change; radiative effects of clouds and aerosols. PREREQUISITE: MA1117 or equivalent.

MR3520 REMOTE SENSING OF THE ATMOSPHERE AND OCEAN (4-0).

Principles of radiative transfer and satellite sensors and systems; visual, infrared and microwave radiometry and radar systems; application of satellite remotely sensed data in the measurement of atmospheric and oceanic variability. PREREQUISITES: Undergraduate physics and differential/integral calculus, ordinary differential equations and MR3480, or consent of instructor.

MR3522 REMOTE SENSING OF THE ATMOSPHERE AND OCEAN/ LABORATORY (4-2).

Same as MR3520 plus laboratory sessions on the concepts considered in the

ecture series. PREREQUISITES: Same as MR3520.

MR3540 RADIATIVE PROCESSES IN THE ATMOSPHERE (3-0).

Applications of radiation theory to atmospheric energy budgets, general circulation and anthropogenic climate changes. Radiational imbalance at the surface leading to heat fluxes and temperature changes in atmosphere and earth. Upper atmosphere phenomena (ozonosphere and ionosphere). Radiative effects of clouds and aerosols, and optical phenomena. PREREQUISITES: MR3420, MR3520 or MR3522.

MR3570 OPERATIONAL OCEANOGRAPHY AND METEOROLOGY (2-4).

Experience at sea acquiring and analyzing oceanographic and atmospheric data using state-of-the-art instrumentation. Integration of satellite remote sensing and other operational products with in situ data. Includes survey of instrumentation, pre-cruise planning, operations at sea and post-cruise analysis. PREREQUISITES: OC3240 and MR3220, or consent of instructor.

MR4241 MESOSCALE METEOROLOGY (3-0).

Descriptive and physical understanding of subsynoptic-scale weather systems including fronts, squall lines, mesoscale convective systems, tornadoes, etc. and their relation to the synoptic-scale environment. Applications to short-range and local-area forecasting utilizing satellite and numerical-model products relevant to mesoscale weather phenomena. PREREQUISITES: MR3230, MR/OC4323, or MR4322 with consent of instructor.

MR4242 ADVANCED TROPICAL METEOROLOGY (3-0).

Theories and observations of equatorial waves and low-frequency oscillations; energy sources and instabilities; monsoon circulations. Tropical cyclone models and forecasting; selected topics in diagnostic and theoretical studies of tropical flows. PREREQUISITES: MR3250 and consent of instructor.

MR4250 ATMOSPHERIC GENERAL CIRCULATION (3-0).

The observed circulation. Zonal mean and eddy motions. Balances of momentum, heat and moisture. Energetics. Maintenance of circulation. Zonally asymmetric circulations. Other selected topics of the general circulation of the atmosphere. PREREQUISITES: MR4322 and consent of instructor.

MR4322 DYNAMIC METEOROLOGY (4-0).

Pressure coordinates, quasi-geostrophic scale analysis, perturbation method; solutions of equations of motion for sound, gravity and synoptic waves; baroclinic and barotropic instability; energetics; geostrophic adjustment. PREREQUISITES: MR3420, MR/OC3321, MA2047, MA2121 or equivalent.

MR4323 NUMERICAL AIR AND OCEAN MODELING (4-2).

Numerical models of atmospheric and oceanic phenomena. Finite difference techniques for solving hyperbolic, parabolic and elliptic equations, linear and nonlinear computational instability. Spectral and finite element models. Filtered and primitive equation prediction models. Sigma coordinates. Objective analysis and initialization. PREREQUISITES: MR4322, OC4211, MA3132; MA3232 desirable.

MR4324 ADVANCED NUMERICAL WEATHER PREDICTION (3-0).

Initialization, boundary conditions; sensible, latent and radiative heat transfer; simulation of sub-grid scale processes such as convection and friction; spectral methods and finite element models; general circulation models. PREREQUISITE: MR/OC4323 or consent of instructor.

MR4331 ADVANCED GEOPHYSICAL FLUID DYNAMICS I (3-0).

Advanced topics in the dynamics of the atmosphere and the oceans including scale analysis; geostrophic adjustment; dispersion, and barotropic and baroclinic instabilities. PREREQUISITE: Consent of instructor.

MR4332 ADVANCED GEOPHYSICAL FLUID DYNAMICS II (3-0).

Normal mode and absolute baroclinic instability; frontogenesis; boundary layer analysis with application; finite amplitude baroclinic waves. PREREQUISITE: Consent of instructor.

MR4413 AIR-SEA INTERACTION (4-1).

Fundamental concepts in turbulence. The atmospheric planetary boundary layer, including surface layer and bulk formulae for estimating air-sea fluxes. The oceanic planetary boundary layer including the dynamics of the well-mixed surface layer. Recent papers in air-sea interaction. PREREQUISITES: MR/OC3150 and OC3240 or MR4322, or consent of instructor.

MR4414 ADVANCED AIR/SEA INTERACTION (3-0).

Advanced topics in the dynamics of the atmospheric and oceanic planetary boundary layers. PREREQUISITE: MR/OC4413 or consent of instructor.

MR4415 ATMOSPHERIC TURBULENCE (3-0).

Approaches for defining the structure of the turbulent atmospheric boundary layer. Review of statistical descriptions of atmospheric turbulence; averaging, moments, joint moments, spectral representation. Equations for turbulent regime in a stratified, shear flow. Scaling parameters and similarity theories for surface layer profiles, spectra; Kolmogorov hypotheses, Monin-Obukhov similarity theory. Measurement of atmospheric turbulence. Examination of observed spectra and scales of atmospheric turbulence. PREREQUISITE: MR/OC3150 or consent of instructor.

MR4416 ATMOSPHERIC FACTORS IN ELECTROMAGNETIC AND OPTICAL PROPAGATION (3-1).

Principles of microwave and optical wave propagation in the atmosphere. Effects of surface and boundary layers on propagation: refraction, scattering, attenuation, ducting, etc. Hands-on experience with existing environmental effects assessment models. PREREQUISITE: MR/OC4413 or MR4415 (may be concurrent).

MR4520 TOPICS IN SATELLITE REMOTE SENSING (3-0).

Selected topics in the advanced application of satellite remote sensing to the measurement of atmospheric and oceanic variables. PREREQUISITE: MR/OC3522.

MR4800 ADVANCED TOPICS IN METEOROLOGY (Variable credit) (V-0).

Advanced topics in various aspects of meteorology. Topics not covered in regularly offered courses. The course may be repeated for credit as topics change. PREREQUISITE: Consent of Department Chairman and instructor.

MR4900 DIRECTED STUDY IN METEOROLOGY (Variable credit) (V-0).

Directed study of selected areas of meteorology to meet the needs of the individual student. PREREQUISITE: Consent of Department Chairman and instructor. Graded on Pass/Fail basis only.

DEPARTMENT OF NATIONAL SECURITY AFFAIRS

Chairman:

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Donald Abenheim, Associate Professor (1985)*; PhD, Stanford University, 1985.

John Arquilla, Assistant Professor (1993); PhD, Stanford University, 1985.

Sherman Wesley Blandin, Jr., Professor Emeritus (1968); PhD, University of Santa Clara, 1977.

Associate Chairmen:

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Jan S. Breemer, Associate Chairman for Research and Associate Professor (1988); PhD, University of Southern California, 1987.

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Thomas C. Bruneau, Chairman and Professor (1987); PhD, University of California at Berkeley, 1970.

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Boyd Francis Huff, Professor Emeritus (1958); PhD, University of California at Berkeley, 1955.

Peter R. Hull, Commander, U.S. Navy (1993); Military Instructor; MS, Naval Postgraduate School, 1985.

Terry Johnson, Adjunct Professor (1993); MA, Georgetown University, 1979.

Roman A. Laba, Associate Professor (1990); PhD, University of Wisconsin, 1989.

Peter Lavoy, Assistant Professor (1993); PhD, University of California at Berkeley, 1995.

Robert Edward Looney, Professor (1979); PhD, University of California at Davis, 1969.

Ralph Harry Magnus, Associate Professor (1976); PhD, University of California at Berkeley, 1971.

Gordon McCormick, Associate Professor (1992); PhD, Johns Hopkins University SAIS, 1985.

Rodney Kennedy Minott, Adjunct Professor (1990); PhD, Stanford University, 1960.

Daniel Moran, Associate Professor (1994); PhD, Stanford University, 1982.

Maria Moyano, Assistant Professor (1993); PhD, Yale University, 1990.

Edward Allan Olsen, Professor (1980); PhD, The American University, 1974.

Patrick Johnston Parker, Professor (1974); MBA, University of Chicago, 1955.

Glenn Edward Robinson, Assistant Professor (1991); PhD, University of California at Berkeley, 1992.

Kamil T. Said, Adjunct Professor (1975); MA, San Jose State College, 1967.

Paul N. Stockton, Associate Professor (1990); PhD, Harvard University, 1986.

Frank Michael Teti, Associate Professor (1966); PhD, Syracuse University, 1966.

Scott D. Tollefson, Assistant Professor (1988); PhD, Johns Hopkins University SAIS, 1991.

Mikhail Tsyppkin, Associate Professor (1987); PhD, Harvard University, 1985.

James J. Wirtz, Associate Professor (1990); PhD, Columbia University, 1989.

David Scott Yost, Professor (1979); PhD, University of Southern California, 1976.

* The year of joining the Naval Postgraduate School faculty is indicated in parentheses.

The Department of National Security Affairs offers programs of study in five major fields, supporting eight different curricula. The five major fields encompass Strategic Planning and International Organizations and Negotiations, Intelligence, Geographic Area Studies, Special Operations/Low Intensity Conflict, and Resource Planning and Management for International Defense. The area studies are subdivided into five groups as follows:

- Middle East, Africa and South Asia
- Far East, Southeast Asia and the Pacific
- Western Hemisphere
- Western Europe
- Russia/Europe/Central Asia

Individual programs in the Area Studies focus on security issues in one of the subregions listed or contain a blend of all subregions in the area. The Area Studies program may include a program of study in a language of the area at the Defense Language Institute, located in Monterey.

The interdisciplinary Strategic Planning program includes conventional and nuclear strategic planning, and the role of related international organizations and processes. Individual programs focus on the evolutionary history of the planning process, strategies for national security, maritime strategy, operations research, management and planning methodologies.

The Intelligence curriculum includes three separate tracks. Scientific and Technical is an interdisciplinary program which integrates political science, mathematics, operations analysis, oceanography, aeronautical engineering, electrical engineering, physics, information systems and managerial economics into an understanding of intelligence. Regional Intelligence focuses on area-specific knowledge from an intelligence perspective. The General Military Intelligence/Economic track focuses on economic and regional intelligence issues of joint intelligence concerns.

The Special Operations/Low Intensity Conflict curriculum provides a focused scope of study of the conflict spectrum below general conventional war. Courses deal with the following topics: international terrorism, theory and practice of guerrilla warfare, role of contingency operations in U.S. security planning, comparative approaches to the problem of low

intensity conflict, and the military and politics in the developing world.

The Resource Planning for International Defense (RePMID) program is offered jointly with the Systems Management Department. Intended specifically for officers and civilian employees in defense agencies of allied countries and emerging democracies, the RePMID program focuses on economic analyses; management of financial, material, and human resources; domestic and international political institutions; civil-military relations; and the role of international law.

Course work in the department addresses four broad fields: defense technology, analysis, management and national security affairs. The defense technology courses are designed to address the special problems of technical intelligence, emphasizing technical literacy and the ability to communicate concerning technological and environmental problems. This sequence seeks to provide the perspective that will assist assessment of the reality and significance of technical and environmental data, as well as ensure familiarity with the resources in these fields that may be applied to intelligence and strategic planning problems.

The analysis and management course work provides the student with a grounding in quantitative techniques, substantive research methods and the concepts of resource management. Students are introduced by various means to structure given problems, formulate possible solutions, organize and compile supporting data, assess the reliability and communicate the significance of the results obtained.

Graduate courses in National Security Affairs outline the interface between international politics, national security objectives, resource management and weapons technology. The sequence synthesizes the political, technological, economic, cultural, social and ideological forces that influence the actors in the international system and models varying scenarios of interaction between them.

An NPS-unique NSA program is the Special Operations/Low Intensity Conflict (SOLIC) curriculum which was created to provide graduate level education to respond to present and most likely forms of conflict or "peacetime engagement." The courses pay particular attention to regional contingency missions, including counterinsurgency, counternarcotics, counterterrorism, and crisis response operations.

DEPARTMENTAL REQUIREMENTS FOR THE DEGREE MASTER OF ARTS IN NATIONAL SECURITY AFFAIRS

- 1) At least 44 units of approved graduate study pertinent to the field of National Security Affairs, of which at least 16 units must be at the 4000 level.
- 2) The completion of an approved sequence of courses in one of the areas of concentration:
 - a. Area Specialization/Regional Intelligence: Completion of graduate courses in the geographic area of specialization, including two 4000 level courses.
 - b. Functional Specialization: Completion of graduate courses in GMI/Economic Intelligence, Strategic Planning and International Organizations and Negotiations, or Special Operations Low Intensity Conflict including two 4000 level courses.
- 3) Successful completion of departmental comprehensive examination or completion of an acceptable thesis.
- 4) Language proficiency, when applicable, for geographic area or Regional Intelligence specialization.

DEPARTMENTAL REQUIREMENTS FOR THE DEGREE MASTER OF SCIENCE IN NATIONAL SECURITY AFFAIRS

The degree Master of Science in National Security (Scientific and Technical Intelligence) Affairs will be awarded upon the completion of an interdisciplinary

program carried out in accordance with the following degree requirements:

- 1) A minimum of 45 quarter hours of graduate level work of which at least 12 hours must represent courses at the 4000 level. Graduate courses in at least three different academic disciplines must be included and in two disciplines a course at the 4000 level must be included.
- 2) An approved sequence of at least three courses constituting advanced study in an area of specialization must be included.
- 3) In addition to the 45 hours of course credit, an acceptable thesis must be completed.
- 4) The program must be approved by the Chairman of the Department of National Security Affairs.

Professional Military Education (PME) and Joint Professional Military Education (JPME) Equivalence

The CNO has granted Service Professional Military Education (PME) equivalence for selected NPS curricula, intended initially for U.S. students in NSA Department curricula in Strategic Planning, Area Studies, Intelligence and SOLIC. The CNO is also requesting the CJCS grant JPME Phase I "equivalence for those officers who complete specific NSA courses which will cover Learning Objectives required by Phase I JPME. When approved, NPS will be added to the CJCS JPME Equivalence List. Transcripts of those students who complete all curriculum ESRs, including the JPME courses, will be annotated to verify their qualification for PME and Phase I JPME.

To ensure all CJC's Phase I JPME Learning Objectives are fully met, a minimum of four courses must be completed. This course coverage is planned for start in AY 95: NS3252 and three others from a menu of six alternative courses will cover all current Phase I Learning Objectives. The NSA Department JPME courses for AY 95 follow:

- 1) NS3252 "Joint and Maritime Strategic Planning"
- 2) NS3000 "War in the Modern World"
NS3050 "History of Joint and Combined Warfare"
- 3) NS3154 "Joint Intelligence and Military Command"
NS3159 "Principles of Joint Operational Intelligence"
- 4) NS3230 "Strategic Planning and the Military"
NS3240 "Military Innovation and Joint Warfare"

COURSE OFFERINGS

NS0810 THESIS RESEARCH (0-8).

Students conducting thesis research will enroll in this course.

NS0811 PREPARATION FOR COMPREHENSIVE EXAMINATION

Students preparing for comprehensive examinations will enroll in this course.

NS0855 EXPERIENCE TOUR (0-0).

Thesis research assignment to the National Maritime Intelligence Center (NMIC) and other Washington area intelligence organizations, for selected students in Track 1 and Track 3 of the Intelligence curriculum. **PREREQUISITES:** Approval of Academic Associate for Intelligence, TOP SECRET clearance with eligibility for SPECIAL COMPARTMENTED INTELLIGENCE information.

NS3000 WAR IN THE MODERN WORLD (4-0).

This course provides an introduction to war as a political and social phenomenon, and as a force in the international system. Major themes include: the development of leading ideas about war; the mutual interactions of politics, society, and warfare; levels of war, with particular emphasis on the operational level; the impact of military doctrine on warfighting; allocation of resources and coordination of effort among land, sea, and air forces; national strategic cultures or styles of war, and their implications for strategic practice. This course covers various learning objectives specified by CJCS Phase One Joint Professional Military Education (JPME) criteria.

NS3011 POLICY ANALYSIS AND RESEARCH METHODS (4-2).

Survey of the methods and techniques used in social scientific inquiry. Topics include policy research design, measurement, sampling, and generation of data using survey research, scaling techniques, interviewing, content analysis, analysis of elites, event data analysis, and archival and bibliographic research techniques. The course emphasizes hypothesis testing, using both statistical methods and the method of structured, focused comparison of case studies. Special focus is placed on applying the principles and methods of social science to the general problem of indications and warning. Laboratory experience includes extensive use of the equipment and software in the NSA computer lab.

NS3012 FORECASTING AND GAMING METHODS FOR STRATEGIC PLANNERS (4-2). (Note: new course, combines NS2060 and NS3013).

Survey of concepts and methods employed in forecasting, wargaming, and simulation that are available for use by military planners and strategists. Includes historical development and recent forecasting, analytical gaming, and simulation techniques applicable to national security planning. Examines a variety of forecasting and gaming methodologies, including the RAND Strategy Assessment System (RSAS). Emphasis is on current and potential uses in the development of strategy, plans and policy.

PREREQUISITES: NS3011 and SECRET NOFORN.

NS3023 INTRODUCTION TO COMPARATIVE POLITICS (4-0). (Note: revised course, International Relations now taught as NS3024).

This course is designed to introduce students to the major intellectual approaches to the study of comparative politics. Readings will be drawn from major theorists and leading schools of thought. Students will confront the central questions on the nature of economic, political, and cultural development.

NS3024 INTRODUCTION TO INTERNATIONAL RELATIONS (4-0). (Note: new course, separate from NS3023)

This course provides an overview of the prominent theories of international relations. It surveys explanations based on decision-making, organizational behavior, domestic politics, international regimes and international systems, especially in terms of the insights they offer into the conduct of international relations in the post-Cold War world.

NS3030 AMERICAN NATIONAL SECURITY POLICY (4-0).

An institutional and functional analysis of the national and international factors that shape U.S. defense policy. Attention is focused on two major areas: (1) the decision-making process, including the legislative-executive budgetary process, as well as the influence of bureaucratic politics and interest group participation upon defense decisions; and (2) the problems of strategic choice, including security assistance, threat analysis, net assessment, deterrence theory, and limited war.

NS3036 THE MILITARY AND POLITICS IN THE DEVELOPING WORLD (4-0).

This course examines the diverse political roles played by the military and paramilitary establishments of the developing world. Particular attention is given to the character of civil-military relations and the pressures, motivations, and consequences of military coups against the established political order. The course examines the different classes

of military involvement, the relationship between national political culture and military roles, and the varying methods of influence open to the armed forces. The course will conclude with an examination of different types of military governments, the consequences of military rule for national stability, and problems inherent in the transition to civilian rule, and the consolidation of democratic regimes. Case studies are drawn from Africa, Latin America, the Middle East, and the Far East with the intention of identifying common and regional patterns in the character civil-military relations in the developing world. **PREREQUISITE:** NS3023 or permission of the instructor.

NS3037 THE ROLE OF CONGRESS IN U.S. NATIONAL SECURITY POLICY (4-0). Survey of the roles, processes and orientations of the U.S. Congress in making national security policy. The course examines the powers and responsibilities granted to Congress by the Constitution, how the role of Congress has changed over time, and the way the role may evolve in the future. Specific topics include the budget process, War Powers, security assistance, and the problems of executive-legislative coordination in foreign and military policy-making.

NS3038 INTERNATIONAL NAVAL POWER AND POLICY (4-0). This course examines the role of international maritime power in peace, crisis and war. It reviews the evolution of the post-World War II global balance of naval power, the roles, missions and capabilities of the principal regional navies (e.g., Japan, India, China, Western Europe, Brazil, and Argentina), and the impact of technological innovation on regional maritime strategies, threats and risks. Specific threat capabilities covered include the proliferation of underwater threat systems (e.g., submarines, mines) and precision-guided weapons. The course focuses on regional, non-superpower naval developments, and their implications for U.S. maritime policy and strategy. **PREREQUISITE:** NS3252 or permission of the instructor.

NS3040 THE POLITICS OF GLOBAL ECONOMIC RELATIONS (4-0). Examination of the world economy. Focuses on implications for the United States of changes in the world trading and financial systems. Topics covered include trade patterns, economic integration, trade blocs, new international economic order, and international economic organizations.

NS3041 COMPARATIVE ECONOMIC SYSTEMS (4-0). An examination of the economic systems and development problems in developing countries, including post-communist states. The course focuses on the political and ideological bases of economic organizations, and the nature of basic economic problems in these regions. Special attention is given to the socio-economic strategies and tactics used in the management of the economy, and institutions and techniques of decision making. Attention is also given to problems of economic stabilization in the developing world. **PREREQUISITE:** NS3040.

NS3079 DIRECTED STUDIES IN NATIONAL SECURITY AFFAIRS (Variable credit; 1-0 to 4-0). (Note: new course, previously NS3279). Format and content vary. Normally involves extensive assigned readings, individual discussions with the instructor, papers and/or examinations.

NS3152 NAVAL WARFARE AND THE THREAT ENVIRONMENT (4-0). This course concentrates on identifying the key warfare issues for successful accomplishment of the U.S. Navy's missions. The evolution of threats is examined in the context of present and future U.S. strategy. **PREREQUISITE:** SECRET clearance is required.

NS3154 INTELLIGENCE AND THE MILITARY (4-0). This course provides an overview of intelligence and related C4I requirements and issues affecting the planning and conduct of joint and combined operations. The U.S. Intelligence Community and C4I structure is studied with emphasis on students knowing the process and application of intelligence and

DAI capabilities to support military commands during joint and combined operations at all levels of war. The organization and functions of the various elements of the national intelligence community are considered. Includes an introduction to systems and organizations supporting the collection, analysis, production, and dissemination of military intelligence to support decision makers. The course is intended for the non-intelligence specialist to help make them aware of national intelligence organizations and their capabilities in acquiring necessary intelligence support for joint commanders. This course covers various learning objectives specified by CJCS Phase One Joint Professional Military Education (JPME) criteria. PREREQUISITES: NS3252 (may be taken concurrently), SECRET NOFORN clearance.

NS3159 PRINCIPLES OF JOINT OPERATIONAL INTELLIGENCE (4-0).

This course examines in detail the problems encountered by an intelligence officer in conducting intelligence collection management, threat analysis and assessments, and dissemination under joint and naval operational conditions. Lectures are provided on the joint intelligence organization with emphasis on the operational aspects of warfighting, on the theory and modern history of operational intelligence, on intelligence in support of battle and amphibious group operations, and on support to joint and naval operations from national and theater level assets, and on the Copernicus and C2WC concepts. Students are required to prepare and present current intelligence briefings and staff intelligence studies emphasizing joint threat analysis and assessments, and the direction of joint collection assets. Guest expert lecturers from the local and Washington intelligence communities are used when possible. Readings are from classified material and from selected literature. This course covers learning objectives specified by CJCS Phase One Joint Professional Military Education (JPME) criteria. The course is conducted at the TOP SECRET SCI level. PREREQUISITE: access to TOP SECRET SCI.

NS3230 STRATEGIC PLANNING AND THE MILITARY (4-0).

Introduction to strategic planning approaches and methods inherent to national security policy formulation and specifically, military defense planning. Includes long range strategic planning, scenario building and forecasting of macro-trends affecting defense policies and capabilities, and the military dimensions of those factors. Theory and process meet through case study/analysis of U.S. defense planning practices and the evolution of the Joint Strategic Planning System (JSPS), including the changing roles of the Joint Staff, Unified CINC and Component, Joint Task Force, and Service staffs following passage of the Goldwater-Nichols Act and post-Cold War international security developments. This course covers various learning objectives specified by CJCS Phase One Joint Professional Military Education (JPME) criteria. PREREQUISITES: NS3030, NS3252 (may be taken concurrently) and SECRET NOFORN clearance.

NS3250 THE ECONOMICS OF U.S. DEFENSE POLICY (4-0).

An examination of the manner in which economic constraints affect the defense allocation process in the United States. Emphasis is placed on the macroeconomic environment in which the budget process is undertaken. Topics include: factors affecting defense expenditures; budgeting for defense; the impact of defense spending on the economy; manpower; and the structure, conduct and performance of defense industries. PREREQUISITE: NS3040 or permission of the instructor.

NS3252 JOINT & MARITIME STRATEGIC PLANNING (4-0).

This course provides students with graduate level understanding of defense strategy in general, and joint and maritime strategy in particular. Major themes include: the development of strategic theory in modern times and its influence on contemporary military organization, force planning, and operations; the roles and missions of land, sea, aerospace and special operations forces; joint organization and doctrine; the interaction between military strategy, foreign policy, and alliance systems; the impact of technological developments on warfare; domestic policy-making processes affecting the armed forces of the United States; joint planning for acquisitions (PPBS) and operations; current defense reform and organization issues. Primary strategic planning

documents are introduced and discussed. Required for all U.S. officer students at NPS. This course covers various learning objectives specified by CJCS Phase One Joint Professional Military Education (JPME) criteria. **PREREQUISITES:** U.S. Citizenship and SECRET clearance.

NS3280 NUCLEAR STRATEGY AND NATIONAL SECURITY (4-0).

This course surveys the history of U.S. nuclear weapons policies and explores deterrence and arms control theories. The course also evaluates the challenges posed by the proliferation of weapons of mass destruction and advanced delivery systems. **PREREQUISITE:** NS3252 or permission of the instructor.

NS3300 HISTORY AND CULTURES OF THE MIDDLE EAST (4-0).

Introduction to the basic geography, culture, society, economy, and religions of the major ethnic and linguistic groups in the Middle East. The course will introduce students to important events and developments, such as the changing conceptions of politics in Islam; the evolving sociological bases of states and societies in the Middle East; and the early impact of Europe on the Middle East, first through trade and then through colonialism.

NS3310 GOVERNMENT AND POLITICS IN THE MIDDLE EAST (4-0).

This introductory course is designed to familiarize students with the politics of contemporary Middle East. The course will cover such topics as the various types of political systems found in the Middle East, the political economy of development, and ethno-nationalist and Islamicist political movements.

NS3320 UNITED STATES INTERESTS AND POLICIES IN THE MIDDLE EAST (4-0).

This course reviews the historical background and current status of American interests and policies in the Middle East. The course focuses on a variety of issues that have occupied American interests, such as: the Arab-Israeli conflict, the security of oil resources, revolutionary change, regional conflicts, and international rivalry of external powers.

NS3360 TOPICS IN MIDDLE EASTERN POLITICS (4-0).

This course examines various topics of central importance in contemporary Middle Eastern politics. These include, for example, nationalism and the state in the Middle East, the politics of Islamicist movements, and the politics of oil.

NS3361 TOPICS IN MIDDLE EASTERN SECURITY (4-0).

This course examines topics of central importance to contemporary Middle Eastern security. It focuses on security issues in at least one of the following: the Maghreb, Israel, the Northern Tier, and the Arabian Peninsula and the adjacent areas.

NS3400 GOVERNMENT AND POLITICS IN RUSSIA, EASTERN EUROPE, AND CENTRAL ASIA (4-0).

An examination of the role of domestic politics in Russia, Eastern Europe, and Central Asian nations. The emphasis is on historical influences, political institutions, ethnic and social problems, and the economy.

NS3401 ETHNO-NATIONALISM IN RUSSIA, EASTERN EUROPE AND CENTRAL ASIA (4-0).

This course introduces students to the states and societies of Russia, Ukraine, Belarus, Latvia, Estonia, Lithuania, Moldova, Georgia, Azerbaijan, Armenia, Kazakhstan, Uzbekistan, Turkmenistan, and Kirgizstan. It also serves as a basic introduction to the broader study of ethnicity and nationalism.

NS3410 RUSSIA, EASTERN EUROPE AND CENTRAL ASIA IN WORLD AFFAIRS (4-0).

This course is concerned with the international conduct and security policies of Russia, the other countries of Eastern Europe, and Central Asia. It examines their major geopolitical, historical, demographic, and economic influences.

NS3450 MILITARY STRATEGY IN RUSSIA, EASTERN EUROPE, AND CENTRAL ASIA (4-0).

The course examines the international factors that condition military strategy and doctrine in Russia, Eastern Europe, and Central Asia. It focuses on contemporary strategic concepts and strategy: conventional war-fighting capabilities, strategy for nuclear war, roles played by the fleets in military strategy, threat and net assessment, and arms control. Emphasis is on the strategic and operational levels of warfare.

PREREQUISITES: NS3252 and SECRET clearance.

NS3460 GOVERNMENT AND SECURITY IN EASTERN EUROPE (4-0).

This course examines the countries of east central Europe that fell into the Soviet sphere of influence after World War II. It is concerned in particular with the complex relationship of Marxism and nationalism, the nature of communist revolution from abroad, revolutions against communist states including Hungary in 1956 and Poland in 1980, and the present situation of the Central European states in the transition from communism to democracy.

NS3501 HISTORY AND CULTURES OF LATIN AMERICA (4-0).

This introductory course examines the heritage of Latin America, from pre-Columbian Indian traditions and Iberian colonial patterns, through the independence movements of the early 19th century, and the global economic relationships that re-oriented the region toward Northwestern Europe and the United States.

NS3510 GOVERNMENT AND POLITICS IN LATIN AMERICA (4-0).

This introductory course is designed to familiarize students with the politics of contemporary Latin America. The course covers such topics as the various types of political systems found in Latin America, the political economy of development, and the issue of regime transition.

NS3520 LATIN AMERICAN INTERNATIONAL RELATIONS (4-0).

This course surveys the international relations of Latin American nations. It analyzes the relations of Latin America with the United States and other nations, both within and outside of the region. Attention is given to political, security, economic and cultural issues.

NS3600 HISTORY AND CULTURES OF EAST ASIA (4-0).

This introductory course addresses the historical development of the peoples of East, South, and Southeast Asia. It emphasizes their economic, political, and military development through the late 19th century.

NS3601 VALUES AND BELIEF SYSTEMS OF ASIA (4-0).

An introduction to the values and belief systems that have shaped the civilizations of East, South, and Southeast Asia. This course addresses the development and practices of Hinduism, Buddhism, Confucianism, Islam, Shintoism, and other belief systems, and the ways they influenced traditional and modern Asia.

NS3620 ASIA AND THE MODERN WORLD (4-0).

An analysis of major national and international developments within Asia, and between Asia and the non-Asian world from the mid-19th century to the late-20th century. Includes an examination of U.S. relations with Asia.

NS3661 GOVERNMENT AND SECURITY IN CHINA (4-0).

An examination of the rise of the Chinese Communist party and establishment of the Communist state; its domestic achievements and problems; the special problem of Taiwan; changing foreign policies and the current role of the People's Republic of China in world affairs. Includes an examination of U.S. relations with China.

NS3662 GOVERNMENT AND SECURITY IN JAPAN (4-0).

An examination of Japan in the contemporary world, focusing on Japan's political dynamics, economic evolution, social transformation, the National Self Defense Forces, and alternatives for ensuring national security. Includes an examination of U.S. relations with Japan.

NS3663 GOVERNMENT AND SECURITY IN KOREA (4-0).

An examination of the division of the Korean nation into two states; the aftermath of the Korean war; domestic political, economic and social problems, of North Korea and South Korea; the prospects for reunification; the military balance and the changing strategic environment; and the relations of Pyongyang and Seoul with their key allies. Includes an examination of U.S. relations with Korea.

NS3667 GOVERNMENT AND SECURITY IN SOUTH ASIA, SOUTHEAST ASIA, AND OCEANIC REGIONS (4-0).

Examines domestic issues and foreign relations among the states in the region of South Asia, Southeast Asia, Australia, New Zealand, and Melanesia. Analyzes the importance of the Indian Ocean and Southwestern Pacific Ocean area, and the strategic interests of the major powers, including the United States.

NS3700 HISTORY OF MODERN EUROPE (4-0).

Review and analysis of the political and military history of Europe, including Russia, from the Congress of Vienna to the present.

NS3710 GOVERNMENT AND SECURITY IN WESTERN EUROPE (4-0).

Survey and analysis of government and security issues in contemporary Western Europe. The course emphasizes the political systems and security policies of Britain, France, Italy, and Germany.

NS3720 EUROPEAN SECURITY INSTITUTIONS (4-0).

Survey and analysis of the main international institutions dealing with European security, including the North Atlantic Treaty Organization (NATO), the Conference on Security and Cooperation in Europe (CSCE), the Western European Union (WEU), and the European Community (EC). The survey includes selected challenges facing each organization, particularly NATO, and their relation to specific European countries and to U.S. foreign and defense policy. PREREQUISITE: NS3252 or permission of the instructor.

NS3800 THEORY AND PRACTICE OF SOCIAL REVOLUTION (4-0).

This course provides an overview of insurgency and counterinsurgency. It reviews the theoretical literature and offers an operational focus, by examining the alternative models of insurgency provided by the doctrine of "people's war," "foco theory," and the urban guerrilla. It also examines the roots and development of U.S. counterinsurgency doctrine, the difference between the "hearts and minds" and systems prescriptions of counterinsurgency, and alternative British, French, and Soviet concepts of counterinsurgency. Four special topics are also analyzed: the role of terror in revolutionary warfare, the relationship between narcotics and insurgency, the questions of guerrillas in power, and a comparison of U.S. counterinsurgency strategy in Vietnam and El Salvador with that currently pursued elsewhere. The course concludes with an examination of the future of guerrilla warfare. PREREQUISITE: NS3023 or permission of the instructor.

NS3801 INTERNATIONAL TERRORISM (4-0).

This course provides an in-depth examination of the origins, nature, and political/military roles of contemporary international terrorism. It briefly examines the early history of terrorism, the contending theories that purport to explain the sources of terrorist behavior, the different types of terrorism and terrorist actions, and the challenge international terrorism poses for American interests and foreign policy. Functional topics, such as the special problems posed by state-sponsored terrorism, the relationship between terrorism and the media, and the range of possible military responses to terrorism are also examined. The course concludes by comparing the

contrasting different national responses to the problem of international terrorism, and examining the difficulties faced by the United States in its efforts to find an effective policy response. PREREQUISITE: NS3023 or permission of the instructor.

NS3880 THE HISTORY OF SPECIAL OPERATIONS (4-0).

Review and analysis of the history of Special Operations from World War II to the present. Case studies of the use of Special Operations Forces by the U.S. and other countries will be examined. PREREQUISITE: NS3023 or permission of the instructor.

NS3881 INTERVENTION AND MID-LEVEL CONFLICT (4-0).

This course provides an overview of the history and current role of (a) military force as a political instrument and (b) contingent intervention in U.S. foreign policy. It examines the nexus between unconventional and conventional warfare concepts and capability. The course is divided into two parts. Part one reviews the political or signalling role of military forces-notably naval forces-short of war. Part two examines the history of U.S. armed intervention and contingent operations in the Third World. The course examines the planning process underlying these and similar actions, and the special decision making problems posed by the need for unanticipated military action in the face of an unclear intelligence picture. PREREQUISITE: NS3800 or permission of the instructor.

NS3882 DETERRENCE, COMPELLENCE, AND CRISIS MANAGEMENT (4-0).

This course surveys current theories of deterrence and coercive diplomacy, relating them to a variety of applied problems in crisis management. Special attention is given to political psychological factors, crisis communication styles, extended deterrence and the implications of proliferation of weapons of mass destruction or conventional deterrence.

NS3900 INTERNATIONAL LAW AND ORGANIZATIONS (4-0).

An introduction to the principles of international law including origins, sources, sovereignty, states, territory, jurisdiction, persons, treaties, settlement of disputes, and the Law of the Sea. The course also traces the evolution of international organizations from the Concert of Europe, through the League of Nations, United Nations, European Economic Community, NATO, and various forms of multi-national and trans-national organizations.

NS3902 MODERN REVOLUTION (4-0).

A study of a general framework and historical cases of modern revolution. Examines the most important revolutions of modern times, including the testing of the methods of systematic analysis.

NS4030 SPECIAL TOPICS IN NATIONAL SECURITY POLICY (4-0).

This seminar focuses on special topics in national security policy. The list of topics to be analyzed for the seminar is announced at least one quarter prior to the offering of the seminar. Advanced study and research is conducted on topics not covered in other seminars. A major, graded research paper is required. PREREQUISITE: Permission of the instructor.

NS4031 SPECIAL TOPICS IN INTERNATIONAL SECURITY AFFAIRS (4-0).

This seminar focuses on current issues in international security affairs. The list of issues to be analyzed for this seminar is announced at least one quarter prior to the offering of the seminar. Advanced study and research is conducted on topics not covered in other seminars. A major, graded research paper is required. PREREQUISITE: Permission of the instructor.

NS4032 SPECIAL TOPICS IN INTERNATIONAL RELATIONS (4-0).

This seminar focuses on current issues in the broader international system. The list of issues to be analyzed for the seminar is announced at least one quarter prior to the

offering of the seminar. Advanced study and research is conducted on topics not covered in other seminars. A major, graded research paper is required.

PREREQUISITE: Permission of the instructor.

NS4033 SPECIAL TOPICS IN U.S. FOREIGN POLICY (4-0). (Note: new course offered in place of NS3035).

This seminar focuses on contemporary issues in U.S. foreign policy. The list of issues to be analyzed for the seminar is announced at least one quarter prior to the offering of the seminar. Advanced study and research is conducted on topics not covered in other seminars. **PREREQUISITE:** Permission of the instructor.

NS4079 ADVANCED DIRECTED STUDIES IN NATIONAL SECURITY AFFAIRS (Variable credit, from 1-0 to 4-0).

Format and content vary. Normally involves extensive individual research under direction of the instructor and submission of a substantial paper of graduate seminar quality and scope. **PREREQUISITE:** Permission of the instructor.

NS4080 RESEARCH COLLOQUIUM (2-0).

A research colloquium in which NSA/Intelligence students present the main findings from their master's thesis research for critical analysis and discussion. **GRADE:** Pass/Fail.

NS4152 SEMINAR IN INTELLIGENCE AND THREAT ANALYSIS (4-0).

Advanced seminar on intelligence support to military commanders and national-level officials. Using case studies, the course examines concepts of individual and organizational decision-making, factors in threat analysis, and issues in intelligence activities. **PREREQUISITES:** NS3159 or permission of the instructor. **TOP SECRET** clearance with eligibility for **SPECIAL COMPARTMENTED INTELLIGENCE** information.

NS4159 SEMINAR IN INTELLIGENCE SUPPORT TO CRISIS OPERATIONS (4-0)

This course continues to examine problems encountered by an operational intelligence officer in conducting intelligence collection management, threat analysis and assessments, and dissemination under naval and joint operational conditions. Lectures are provided on additional aspects of operational intelligence in support of naval and joint warfare including strategic nuclear, counterinsurgency, operational deception, and wargaming on a modern microworkstation. The students study and critique classified case studies from joint operations (Eldorado Canyon, Earnest Will, and Desert Storm). The course includes a field trip to visit staffs, ships and centers engaged in joint and naval operational intelligence. The course culminates in a Battle Group/Joint Task Force intelligence problem covering the entire spectrum of operational intelligence. Course readings are from classified material, selected literature, and statements by leading intelligence officials. The course is conducted at the **TOP SECRET SCI** level.

NS4200 SEMINAR IN THE NATIONAL INTEREST (4-0). (Note: previously NS4500).

An advanced study of the underlying assumptions and objectives of American security and foreign policy. The core of the course is an in-depth analysis of approaches to understanding the American national interest in the international context. Students are required to write a major seminar paper on American national interests in a specific country or region. **PREREQUISITES:** NS3252 and NS3030.

NS4230 SEMINAR IN STRATEGIC PLANNING (4-0).

Advanced study in the concept and methods of strategic planning and analysis, particularly with respect to the Department of the Navy and other services, the Joint Chiefs of Staff, the Office of the Secretary of Defense, the Department of State, the National Security Council, White House, and the Congress. **PREREQUISITES:** NS3030 and NS3230 or permission of the instructor. **SECRET** clearance.

NS4240 SEMINAR IN REGIONAL SECURITY PLANNING PROBLEMS (4-0).
This seminar, which is the national security policy capstone course in the Resource Planning for Management and International Defense (REPMID) curriculum, provides advanced study of regional and inter-regional security problems which are likely to confront emerging democracies in the immediate and mid-range future. Potential roles of individual countries and coalitions are explored to develop new and innovative strategies for dealing with both common and unique security problems in diverse regions. Through the course readings, students critically analyze the implications of the most likely future security environment challenges and opportunities for each region. **PREREQUISITE:** Completion of previous REPMID courses, or consent of instructor. **CLASSIFICATION:** None.

NS4250 SEMINAR IN SECURITY ASSISTANCE AND ARMS TRANSFERS (4-0).
An analysis of the patterns, purposes and effects of cross-national security assistance, including arms sales and the transfer of technology. Special topics include: factors dominating the arms transfer policies of the major powers; the design, execution and evaluation of security assistance programs. **PREREQUISITE:** NS3030.

NS4251 SEMINAR IN NET ASSESSMENT (4-0).
The seminar examines the methodology of comparative threat analysis (net assessment), including: security policies, forces, and capabilities of the world's military superpowers. The course introduces the student to original source material. **PREREQUISITES:** NS3230, NS3252, NS3280, and NS3450. TOP SECRET clearance with eligibility for SPECIAL COMPARTMENTED INTELLIGENCE information.

NS4253 TECHNOLOGY AND STRATEGIC PLANNING (4-0).
This course is intended to develop an understanding of the interrelationship of technology and strategic planning. Issues include technological risk, affordability, institutional impediments to innovation, and a strategy for long range technology investments. **PREREQUISITE:** NS3030, or NS3230, or NS3252, or permission of the instructor. SECRET clearance.

NS4261 SURVEY OF STRATEGIC STUDIES (4-0).
Survey of the classical and contemporary literature on strategic thinking: national objectives and strategic alternatives; deterrence, counterforce, arms control, counterinsurgency; components and rules of the international strategic system; and arms competitions, nuclear proliferation, and terrorism. **PREREQUISITE:** NS3030 or permission of the instructor.

NS4280 SEMINAR IN NUCLEAR STRATEGY (4-0).
A follow-up course to NS3280 that examines selected issues in nuclear strategy, the proliferation of weapons of mass destruction, and deterrence. In addition to theoretical issues of deterrence, this course will specifically investigate the role and importance of nuclear force planning and strategy formulation in deterrence, stability, and foreign policy implementation. **PREREQUISITES:** NS3280. TOP SECRET clearance and, depending on the instructor's requirements, eligibility for SPECIAL COMPARTMENTED INTELLIGENCE information.

NS4300 SEMINAR IN MIDDLE EASTERN POLITICS (4-0).
A research seminar on politics in contemporary Middle East. Students conduct and present original research on selected issues concerning Middle Eastern politics. **PREREQUISITE:** NS3300 or permission of the instructor.

NS4310 SEMINAR IN MIDDLE EASTERN SECURITY ISSUES (4-0).
A research seminar on security issues in contemporary Middle East. Students conduct and present original research on selected issues concerning Middle Eastern security. **PREREQUISITE:** NS3310 or permission of the instructor.

NS4410 SEMINAR IN SECURITY ISSUES IN RUSSIA, EASTERN EUROPE AND CENTRAL ASIA (4-0).
This advanced seminar addresses the security problems of the successor states to the

former Soviet Union, focusing on the military, the security environment, political culture, Russian and non-Russian nationalisms, and the relationship between domestic and foreign policies. PREREQUISITE: NS3400, or NS4310, or NS3450, or permission of the instructor.

NS4451 SEMINAR IN RUSSIAN/CENTRAL EURASIAN NAVAL AFFAIRS (4-0).

Advanced study in emerging Russian/Central Eurasian naval and maritime affairs in the context of a changing international security environment. Topics include: politico-military decision-making processes, scenario building, military doctrines and strategies, strategic missions, naval operational art, warfare capabilities and support systems, data bases and gaming, threat and net assessment, and arms control.

PREREQUISITES: NS3252 and/or NS3450. TOP SECRET clearance with eligibility for SPECIAL COMPARTMENTED INTELLIGENCE information.

NS4510 SEMINAR IN LATIN AMERICAN GOVERNMENT AND POLITICS (4-0).

An advanced seminar on Latin American politics and government. The topics analyzed include those of most current relevance including political transitions, the changing role of different political movements and institutions, and the prospects for economic growth and political stability. PREREQUISITE: NS3510 or NS3520, or permission of the instructor.

NS4560 SEMINAR IN LATIN AMERICAN SECURITY ISSUES (4-0).

A research seminar on security issues in contemporary Latin America. Students conduct and present original research on selected issues concerning Latin American security. PREREQUISITE: NS3510 or NS3520, or permission of the instructor.

NS4660 SEMINAR IN ASIA IN WORLD AFFAIRS (4-0).

Advanced study of Asia's contemporary economic, security, diplomatic, and cultural roles in world affairs, with special emphasis upon the policy interaction of China, Japan, India, and other key states with the United States, Russia, Europe, and the developing world. PREREQUISITE: A NS3000-level course on Asia, or permission of the instructor.

NS4690 SEMINAR IN INTERNATIONAL SECURITY ISSUES OF ASIA (4-0).

Advanced study of Asian security issues with special emphasis on the balance of forces, regional and external alliances, prospects for conflict, and Asian concepts of security and strategy. PREREQUISITE: A NS3000-level course on Asia, or permission of the instructor.

NS4710 SEMINAR IN EUROPEAN POLITICS (4-0).

A research seminar on politics in contemporary Europe. Students conduct and present original research on selected issues concerning European politics, with an emphasis on defense and security problems. PREREQUISITE: NS3710 or permission of the instructor.

NS4720 SEMINAR IN EUROPEAN SECURITY ISSUES (4-0)

A research seminar on security issues in contemporary Europe. Students conduct and present original research on selected issues concerning European security. PREREQUISITE: NS3720 or permission of the instructor.

NS4830 REGIONAL SEMINAR IN LOW-INTENSITY CONFLICT : MIDDLE EAST (4-0)

As part of the regional seminar series, this course examines low intensity conflict issues in the Middle East. The seminar reviews the theoretical literature on political violence and analyzes the recent history of Middle East-based terrorism and insurgency. It offers a series of detailed case studies of local organizations and conflict, and focuses on functional issues in the Middle East. PREREQUISITES: NS3036, NS3800 and NS3880 or permission of the instructor. CLASSIFICATION: None.

NS4850 REGIONAL SEMINAR IN LOW-INTENSITY CONFLICT : LATIN AMERICA (4-0)

As part of the regional seminar series, this course examines low intensity conflict issues in Latin America. The seminar reviews the theoretical literature on political violence and analyzes the recent history of Latin American-based terrorism and insurgency. It offers a series of detailed case studies of local organizations and conflict, and focuses on functional issues in Latin America. PREREQUISITES: NS3036, 3800 and 3880 or permission of the instructor. CLASSIFICATION: None.

NS4860 REGIONAL SEMINAR IN LOW-INTENSITY CONFLICT : ASIA (4-0)

As part of the regional seminar series, this course examines low intensity conflict issues in Asia. The seminar reviews the theoretical literature on political violence and analyzes the recent history of Asian-based terrorism and insurgency. It offers a series of detailed case studies of local organizations and conflict, and focuses on functional issues in Asia. PREREQUISITES: NS3036, NS3800 and NS3880 or permission of the instructor. CLASSIFICATION: None.

NS4880 LEGAL AND MILITARY RESPONSES TO VIOLENCE (4-0)

The course will first review the variety of legal and military policy options open to any state that confronts political violence, with particular attention to short vs. long term consequences of different policy options. We will then analyze a few individual cases (the British in Ulster, violence in Spain) in depth, in order to assess how different policy options combine or cancel each other.

NS4900 SEMINAR IN INTERNATIONAL NEGOTIATIONS (4-0).

Advanced study in the international negotiating process, designed to provide students with an opportunity to analyze specific topics related to negotiating national security. Includes study of Peace Support Operations. PREREQUISITE: NS3900 or permission of the instructor.

NS4902 SEMINAR IN MODERN REVOLUTION (4-0).

A research seminar on modern revolution. Students conduct and present original research on selected issues concerning modern revolution. PREREQUISITE: NS3902 or permission of the instructor.

DEPARTMENT OF OCEANOGRAPHY

Mary Louise Batteen, Associate Professor (1985)*; PhD, Oregon State University, 1984.

Robert Hathaway Bourke, Professor and Chairman (1971); PhD, Oregon State University, 1972.

Everett Carter, Assistant Professor (1990); PhD, Harvard University, 1986.

Ching-Sang Chiu, Associate Professor (1988); ScD, Massachusetts Institute of Technology and Woods Hole Oceanographic Institution, 1985.

Peter C. Chu, Associate Professor (1986); PhD, University of Chicago, 1985.

James R. Clynych, Research Professor (1990); PhD, Brown University, 1974.

Curtis Allan Collins, Professor (1987); PhD, Oregon State University, 1967.

Newell Garfield, III, Research Assistant Professor (1989); PhD, University of Rhode Island, 1989.

Roland William Garwood, Professor and Associate Chairman for Academic Affairs, (1976); PhD, University of Washington, 1976.

Eugene Clinton Haderlie, Distinguished Research Professor Emeritus (1965); PhD, University of California at Berkeley, 1950.

Thomas H.C. Herbers, Assistant Professor (1993), PhD, University of California, San Diego, 1990.

Lin Jiang, Research Associate (1993), PhD, University of British Columbia, 1993.

Glenn Harold Jung, Professor Emeritus (1958); Texas A & M University, 1955.

Dale Fredrick Leipper, Professor Emeritus (1968); PhD, Scripps Institution of Oceanography, 1950.

Thomas Lippman, National Research Council Postdoctoral Associate (1992), PhD, Oregon State University, 1992

Le Ngoc Ly, Research Associate Professor (1993), PhD, State Hydromet Institute, St. Petersburg, 1976.

Wieslaw Maslowski, Lecturer (1994); PhD, University of Alaska-Fairbanks, 1994.

Julie McClean, Research Associate (1993), PhD, Old Dominion University, 1993.

Jeffrey Dean Paduan, Assistant Professor (1991); PhD, Oregon State University, 1987.

Robert George Paquette, Research Professor Emeritus (1971); PhD, University of Washington, 1941.

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Associate Chairmen:

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Professor
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Academic Affairs
Roland W. Garwood, Jr.,
Professor
Code OC/Gd, Spanagel Hall
Room 308
(408) 656-3260
DSN 878-3260

Steven Richard Ramp, Associate Research Professor (1986); PhD, University of Rhode Island, 1986.

Leslie K. Rosenfeld, Research Assistant Professor (1989); PhD, Woods Hole Oceanographic Institution, 1987.

Franklin B. Schwing, Visiting Professor (1992); PhD, Dalhousie University, 1989.

Albert Julius Semtner, Jr., Professor (1986); PhD, Princeton University, 1973.

Timothy Peter Stanton, Research Associate Professor (1978); MS, University of Auckland, 1977.

Warren Charles Thompson, Professor Emeritus (1953); PhD, Texas A & M University, 1953.

Edward Bennett Thornton, Professor and Associate Chairman for Research, (1969); PhD, University of Florida, 1970.

Eugene Dewees Traganza, Professor Emeritus (1970); PhD, University of Miami, 1966.

Stevens Parrington Tucker, Professor Emeritus (1968); PhD, Oregon State University, 1972.

Joseph John von Schwind, Professor Emeritus (1967); PhD, Texas A & M University, 1968.

Jack B. Wickham, Professor Emeritus (1951); MS, Scripps Institution of Oceanography, 1949.

James H. Wilson, Research Professor (1992); PhD, The Pennsylvania State University, 1974.

* The year of joining the Naval Postgraduate School faculty is indicated in parentheses.

The Oceanography Department primarily supports curricula sponsored by the Oceanographer of the Navy, #373 Air-Ocean Science, #374 Operational Oceanography, #440 Oceanography.

The department focuses on Physical Oceanography, Acoustical Oceanography and Nearshore and Coastal Oceanography.

Topics include ocean dynamics, numerical ocean circulation modeling, satellite remote sensing of the ocean, air-sea interaction, Arctic oceanography, upper ocean dynamics and thermodynamics, near-shore processes, mesoscale dynamics, synoptic/mesoscale ocean prediction, coastal ocean circulation and environmental acoustics. The department also provides core courses for USW and the Space Systems curricula.

MASTER OF SCIENCE IN PHYSICAL OCEANOGRAPHY

Entrance to a program leading to the degree Master of Science in Physical Oceanography requires a baccalaureate degree. Minimal requirements include mathematics through differential and integral calculus and one year of calculus-based physics.

The degree Master of Science in Physical Oceanography requires:

- 1) Completion of at least eight physical oceanography graduate courses with at least four courses in the OC4000 series. The entire sequence of courses selected must be approved by the Department of Oceanography. Significant educational

experience at sea on a research vessel is required for the degree. (OC3570 satisfies this requirement).

- 2) Completion of an acceptable thesis on a topic approved by the Department of Oceanography.

MASTER OF SCIENCE IN METEOROLOGY AND PHYSICAL OCEANOGRAPHY

Direct entrance to a program leading to the degree Master of Science in Meteorology and Physical Oceanography requires a baccalaureate degree in one of the physical sciences, mathematics, or engineering. This normally permits the validation of a number of required undergraduate courses such as physics, differential equations, linear algebra, vector analysis and various courses in meteorology and/or oceanography, which are prerequisites to the graduate program. These prerequisites may be taken at the Naval Postgraduate School; however, in that event the program may be lengthened by one or more quarters.

The degree Master of Science in Meteorology and Physical Oceanography requires:

- 1) Necessary prerequisite courses in mathematics (through partial differential equations), meteorology and physical oceanography.
- 2) The sequence of core courses in meteorology and oceanography in the fields of dynamical, numerical and physical and synoptic meteorology and oceanography.
- 3) An approved selection of graduate elective courses in meteorology and oceanography.
- 4) A significant educational experience at sea on a research vessel.
- 5) An acceptable thesis on a topic approved by either department.

The total number of quarter hours in (2) and (3) above must be at least 48. These 48 hours must include 20 hours at the 4000 level in courses other than directed study and they should show an approximate balance between the disciplines of Meteorology and Physical Oceanography.

DOCTOR OF PHILOSOPHY

Department of Oceanography admission requirements for the degree Doctor of Philosophy include:

- 1) A master's degree (or the equivalent) in one of the physical sciences, mathematics, or engineering or,
- 2) A bachelor's degree with a high QPR or,
- 3) A highly successful first graduate year in a Master's program, with clear evidence of research ability.

The Ph.D. Program is in Physical Oceanography, including areas of study in ocean circulation theory, air-sea interaction, ocean acoustics and nearshore oceanography among others. To undertake doctoral work in oceanography, a student must apply to the Chairman, Department of Oceanography. A copy of the Oceanography Ph.D. Program Guidelines is available from the Department of Oceanography.

OCEANOGRAPHIC LABORATORIES

NPS is a member of UNOLS (University National Oceanography Laboratory System) and of CENCAL (Central California Cooperative). UNOLS operates the Nation's academic oceanographic research fleet, while CENCAL promotes and coordinates research vessel operations between several academic institutions in Central California.

The nearby Moss Landing Marine Laboratory operates the NSF-owned, 135-foot R/V POINT SUR for the benefit of CENCAL. Through sponsorship of the Oceanographer of the Navy, NPS is a major user of the R/V POINT SUR, primarily for instructional purposes.

A moored-equipment laboratory provides for instruction in the practical design, deployment and recovery of state-of-the-art oceanographic instrumentation. Real-time observations of currents, temperature, salinity and sound speed structure in a variety of oceanic regimes are analyzed, applying theoretical and mathematical techniques learned in the classroom to Naval Oceanography problems.

NPS is also a member of UCAR (University Corporation for Atmosphere Research), which serves some of the computational and other research facility needs of the oceanographic community. Together with the Meteorology Department, the Oceanography Department operates the Interactive Digital Experimental Analysis Laboratory (IDEA) that is equipped with several workstations for the analysis of satellite images or other digital fields, e.g., numerical model output. In addition, the Department operates a Graphics Laboratory with 12 networked workstations for simulation and analysis of oceanographic data. This laboratory is connected to the Idea lab expanding the capabilities of this lab for instructional purposes.

NPS has recently acquired the former PT SUR SOSUS underwater acoustic array. Acoustic signals can now be brought into the classroom in real time to demonstrate signal processing, ambient noise and beam forming techniques.

The Department is organized around thematic laboratories, each containing faculty, staff and student offices, computing facilities and special laboratory equipment. Thematic laboratories exist for Oceanic Planetary Boundary Layer, Polar, Near shore, Acoustics, Coastal Modeling, Langrangian Drifters and Electronics and Calibration.

COURSE OFFERINGS

OC0810 THESIS RESEARCH. (0-8).

Every student conducting research in Oceanography will enroll in this course.

OC0999 THESIS SEMINARS (NO CREDIT)(2-0).

Students in the various oceanography curricula present their thesis research.

PREREQUISITE: Preparation of a thesis.

OC2020 COMPUTER COMPUTATIONS IN AIR-OCEAN SCIENCES. (1-2).

Introduction to MATLAB, and the Unix environment, as applied to elementary problems in oceanography and meteorology. **PREREQUISITES:** Calculus and college physics.

OC3030 ENVIRONMENTAL COMPUTING AND DATA DISPLAY (1-2).

Course emphasizes the use of the computer as a tool in oceanography and meteorology problem-solving. Use of various software packages for graphics, scientific visualization, statistics and numerical computation. The laboratory portion of this course is directed towards completion of an individual project with application to a geophysical environmental problem. **PREREQUISITES:** OC/MR2020, OC3240 or MR/OC3522, or the consent of the instructor.

C3120 BIOGEOCHEMICAL PROCESSES IN THE OCEAN. (4-3).

Basic biological, geological, and chemical processes in the ocean. Biocoustics, deep scattering layers, and bio-deterioration. Geomorphic features of the ocean floor; kinds and distribution of ocean bottom features. Chemical composition of the ocean.

OC3140 PROBABILITY AND STATISTICS FOR AIR-OCEAN SCIENCE. (3-2).

Basic probability and statistics, in the air-ocean science context. Techniques of statistical data analysis. Structure of a probability model, density distribution function expectation, and variance. Binomial, Poisson and Gaussian distributions. Conditional probability and independence. Joint distributions, covariance and central limit theorem. Transformations of random variables. Histograms and empirical distributions and associated characteristics such as moments and percentiles. Standard tests of hypotheses and confidence intervals for both one-and two-parameter situations. Regression analysis as related to least squares estimation. PREREQUISITE: Calculus.

OC3150 ANALYSIS OF AIR OCEAN TIME SERIES. (3-2).

Analysis methods for atmospheric and oceanic time series. Fourier transforms applied to linear systems and discrete data. Correlation functions, power density spectra and cross-spectrum. Optimal design of air-ocean data network. Laboratory work involves analysis of actual atmospheric and ocean time series using principles developed in class. PREREQUISITES: MA 3132 and a probability and statistics course.

OC3210 POLAR OCEANOGRAPHY (3-0).

Covers the ice characteristics and physical oceanography of polar seas. Sea ice: types, physical and mechanical properties, heat flux, temporal and spatial distribution, melting and freezing processes, forecasting models, and remote sensing of ice/snow covered surfaces. Physical oceanography of currents and water masses, deep and bottom water formation, fronts and eddies, polynya processes, and underwater acoustics. Discuss naval and research operations in polar warfare. PREREQUISITE: OC3240

OC3212 POLAR METEOROLOGY/OCEANOGRAPHY. (4-0).

Operational aspects of Arctic and Antarctic meteorology, including polar lows, boundary layer and marginal ice zone influences. Polar oceanography. Sea ice amount, seasonal distribution, melting and freezing processes, physical and mechanical properties, drift and predictions. Physical oceanography of currents and water masses, deep and bottom water formation, fronts and eddies, polynya processes. PREREQUISITE: MR3222 and OC3240 or consent of instructor.

OC3230 DESCRIPTIVE PHYSICAL OCEANOGRAPHY. (3-1).

Physical properties of seawater. Processes influencing the distribution of heat, salt and density in the ocean. Static stability in the ocean. Circulation and water masses in the ocean. Laboratory work involves at sea collection and analysis of actual data using principles developed in class. PREREQUISITE: MR/OC2020 or the equivalent (may be concurrent).

OC3240 OCEAN DYNAMICS I. (4-2).

Application of dynamical concepts of ocean circulation, including conservation of mass, momentum and energy. Oceanic currents without friction: inertial and geostrophic flows. Frictional currents: Reynolds equations, Ekman and wind-driven flows. Vorticity balance: Sverdrup transport, potential vorticity, topographic steering, western intensification and Rossby waves. Thermohaline effects and thermocline theory. PREREQUISITES: OC3230 and OC3321 or the equivalent.

OC3260 SOUND IN THE OCEAN. (4-0).

The fundamentals of ocean acoustics including the acoustic wave equation, ray theory, acoustic arrays and filters, ambient noise, scattering, absorption, an introduction to normal mode theory, and sonar equations. PREREQUISITES: OC 3230, MA 3132 or equivalent.

OC3266 OPERATIONAL ACOUSTIC FORECASTING (3-2).

Course emphasizes tactical use of the environment as a force multiplier in acoustic USW. Tactical guides involving ducts, fronts, eddies and bottom structure are examined

range-dependent propagation loss models Emerging tactics using LFA, VLF and Fixed Distributed systems and non-acoustic methods are reviewed. PREREQUISITES: OC4267, SECRET NOFORN clearance.

OC3321 AIR-OCEAN FLUID DYNAMICS. (4-0).

A foundation course for studies of atmospheric and oceanographic motions. The governing dynamical equations for rotating stratified fluid are derived from fundamental physical laws. Topics include the continuum hypothesis, real and apparent forces, derivations and applications of the governing equations, coordinate systems, scale analysis, simple balanced flows, boundary conditions, thermal wind, barotropic and baroclinic conditions, circulation, vorticity, and divergence. PREREQUISITE: MA2049

OC3325 MARINE GEOPHYSICS. (3-0).

Theory and methods of marine geophysics surveys, and emphasis on gravity, magnetism, seismic and acoustic wave propagation; geophysical anomalies associated with major seafloor features; marine geodesy. PREREQUISITE: MR 2121 (may be concurrent).

OC3445 OCEANIC AND ATMOSPHERIC OBSERVATIONAL SYSTEMS. (2-2).

Principles of measurement; sensors, data acquisition systems, calibration, etc. Methods of measurement for thermodynamic and dynamic variables in the ocean and atmosphere, including acoustics and optics. PREREQUISITES: OC 3230 and MR 3420, MR/OC 3150 or consent of instructor.

OC3520 REMOTE SENSING OF THE ATMOSPHERE AND OCEAN. (4-0).

Principles of radiative transfer and satellite sensors and systems; visual, infrared and microwave radiometry, and radar systems; application of satellite remotely-sensed data in the measurement of atmospheric and oceanic variability. PREREQUISITES: Undergraduate physics and differential/integral calculus; ordinary differential equations or consent of instructor.

OC3522 REMOTE SENSING OF THE ATMOSPHERE AND OCEAN/ LABORATORY. (4-2).

Same as OC3520 plus laboratory sessions on the concepts considered in the lecture series. PREREQUISITES: Same as OC 3520.

OC3570 OPERATIONAL OCEANOGRAPHY (2-4).

Experience at sea acquiring and analyzing oceanographic data using state of the art instrumentation. Integration of satellite remote sensing and other operational products with in-situ data. Includes survey of instrumentation, pre-cruise planning, operations at sea, and post-cruise analysis. PREREQUISITES: OC3240 or consent of instructor.

OC3610 WAVE AND SURF FORECASTING. (2-2).

Theory and prediction of wind-generated ocean waves. Spectral transformation of waves from deep to shallow water. Prediction of surf and wave related influences on operations. PREREQUISITES: OC 3150, OC 4211.

OC3750 NAVAL ASTRONOMY AND PRECISE TIME (2-0).

Positional astronomy. Coordinate systems. Solar system dynamics. Astrometry (measurements of positions and motion of stars). Time, earth rotation and atomic clocks. Naval applications of astronomy. Overview of astrophysics and cosmology. PREREQUISITES: College physics and calculus.

OC3903 ELECTRONIC SURVEYING AND NAVIGATION. (3-0).

Introduction to the theory and practice of electronic navigation including principles of electronics, geometry, and error propagation. Covers ground-based and satellite systems. The global positioning system is covered in detail. PREREQUISITE: Consent of instructor.

OC4211 OCEAN DYNAMICS II. (4-0).

Linear theory of surface, internal, inertial-internal and Rossby waves, barotropic and baroclinic instabilities. Coastal and equatorial trapped waves. PREREQUISITES: MA3132 and OC3240.

OC4212 TIDES. (4-0).

Development of the theory of tides including the tide-producing forces, equilibrium tides, and the dynamic theory of tides; harmonic analysis and prediction of tides; tidal datum planes and their relationship with geodetic datum planes, short-term and secular changes in sea level. PREREQUISITES: OC 4211.

OC4213 NEARSHORE AND WAVE PROCESSES. (3-1).

Shoal-water wave processes, breakers and surf; nearshore water circulation; beach characteristics; littoral drift; coastal hydraulics; storm surge. PREREQUISITE: OC 4211 or consent of instructor.

OC4220 COASTAL CIRCULATION (4-1).

Coastal ocean physical processes. Dynamics and models of coastal ocean circulations driven by wind, thermohaline, tidal, boundary currents, and ocean eddy forces. Recent papers on coastal ocean circulation. Laboratory sessions on computing properties of tides coastal trapped waves and wind-driven motions over the shelf and slope. PREREQUISITE: OC4211.

OC4230 PHYSICAL OCEANOGRAPHY OF MONTEREY BAY (3-0).

Monterey Bay will be used as a case study for various processes affecting the physical oceanography of coastal environments. Topics to include coastal upwelling, flow in and around submarine canyons, internal waves, air-sea interactions, and tides and seiches. Historical, recent, and ongoing studies in and around the Bay will be considered. PREREQUISITE: OC4211 or consent of instructor.

OC4250 GENERAL CIRCULATION OF THE ATMOSPHERE AND OCEANS.

(3-0). Selected topics on the general circulation of the atmosphere (e.g. heat, momentum and moisture fluxes; energetics) and ocean (e.g. linear and non-linear theories of the wind-driven ocean circulation); coupled ocean-atmosphere general circulation models. PREREQUISITE: Consent of instructor.

OC4262 THEORIES & MODELS IN UNDERWATER ACOUSTICS (3-0).

Development of the underlying theories and algorithms of ray, normal mode, and parabolic equation acoustic models for both range independent and dependent environments. Examination of the strengths and weaknesses of and similarities between the various models. PREREQUISITES: OC 3260, and MA 3132 or equivalent.

OC4267 OCEAN ACOUSTIC PREDICTION (4-0).

Examines sound speed profiles (time and space variability), ambient noise, absorption, and reflection and scattering from the sea surface and bottom as they affect sound propagation in the ocean. Synoptic prediction techniques for ambient noise and transmission loss are reviewed. Environmental data input and computational approximations for acoustic models are evaluated against observed signal fluctuations and transmission loss. The course is designed for the Air-Ocean Science, Operational Oceanography, and USW Curricula. PREREQUISITES: OC3230 and OC3260 or equivalent.

OC4323 NUMERICAL AIR AND OCEAN MODELING. (4-2).

Numerical models of atmospheric and oceanic phenomena. Finite difference techniques for solving elliptic and hyperbolic equations, linear and non-linear computational instability. Spectral and finite element models. Filtered and primitive equation prediction models. Sigma coordinates. Objective analysis and initialization. Moisture

and heating as time permits. PREREQUISITES: MR 4322, or OC 4211, MA 3132; MA3232 desirable.

OC4324 ADVANCED NUMERICAL OCEAN MODELING. (3-0).

Advanced techniques for simulating and predicting ocean circulation, including recent modeling results. Topics to include multi-layer quasi-geostrophic models, multi-level primitive equation models, treatment of irregular geometry and open boundary conditions, satellite data assimilation and computer technology considerations.

PREREQUISITE: MR/OC 4323.

OC4331 MESOSCALE OCEAN VARIABILITY. (4-0).

Contemporary knowledge of ocean mesoscale eddies, fronts, meandering currents; baroclinic and barotropic instabilities; kinematics, dynamics and energetics from observations, theories and models. PREREQUISITE: OC4211.

OC4335 NAVAL OCEAN ANALYSIS AND PREDICTION (3-2).

Advanced knowledge of the U.S. naval ocean analysis and prediction systems, including the naval ocean modeling program (NOMP), naval ocean data systems, atmospheric forcing systems, data assimilation systems, optimal thermal interpolation system (OTIS), thermal ocean prediction systems (TOPS), the global ocean circulation prediction system, shallow water analysis and forecast system (SWAFS), polar ice prediction system (PIPS), and global wave prediction system (WAM). PREREQUISITE: OC4211 and MR/OC 4323 (may be concurrent).

OC4413 AIR/SEA INTERACTION. (4-0).

Fundamental concepts in turbulence. The atmospheric planetary boundary layer, including surface layer, and bulk formulae for estimating air-sea fluxes. The oceanic planetary boundary layer including the dynamics of the well-mixed surface layer. Recent papers on large-scale air-sea interaction. PREREQUISITES: MR/OC3150, OC3240 or MR 4322, or consent of instructor.

OC4414 ADVANCED AIR/SEA INTERACTION. (3-0).

Advanced topics in the dynamics of the atmospheric and oceanic planetary boundary layers. PREREQUISITE: MR/OC 4413 or consent of instructor.

OC4415 OCEAN TURBULENCE (3-0).

Advanced topics in the dynamics of ocean turbulence, wakes and microstructure. PREREQUISITE: MR/OC 4413 or consent of instructor.

OC4490 OCEAN ACOUSTIC TOMOGRAPHY (same as EC4490) (3-0).

An introduction to Ocean Tomography, an underwater acoustic inverse technique for mapping ocean sound speed and current fields. Covers the major aspects of Ocean Acoustic Tomography, including the underlying concepts, the design and transmission of tomographic signals, and linear inverse methods for the reconstruction of ocean fields. PREREQUISITES: OC3260 or EC3450 or PH4453 or equivalent; MA2042, MA3132 or equivalent.

OC4520 TOPICS IN SATELLITE REMOTE SENSING. (3-0).

Selected topics in the advanced application of satellite remote sensing to the measurement of atmospheric and oceanic variables. PREREQUISITE: MR/OC 3522.

OC4800 ADVANCED COURSES IN OCEANOGRAPHY. (V-0).

Advanced courses in various aspects of oceanography. Typically these are advanced topics not covered in regularly offered courses. The course may be repeated for credit as topics change. PREREQUISITE: Consent of the Department Chairman and instructor.

OC4900 DIRECTED STUDY IN OCEANOGRAPHY (V-0).

Independent study of advanced topics in oceanography. PREREQUISITE: Consent of the Department Chairman and instructor. Graded on Pass/Fail basis only.

DEPARTMENT OF OPERATIONS RESEARCH

Michael Page Bailey, Associate Professor (1988)*; PhD, University of North Carolina, 1988.

Kevin John Becker, LCDR, USN, Military Instructor (1994); MS, Naval Postgraduate School, 1986.

Paul Bloch, Lecturer (1994); MS Naval Postgraduate School, 1979.

Dan Calvin Boger, Professor (1979); PhD, University of California at Berkeley, 1979.

Gordon Hoover Bradley, Professor (1973); PhD, Northwestern University, 1967.

Gerald Gerard Brown, Professor (1973); PhD, University of California at Los Angeles, 1974.

Don Brutzman, LCDR, USN, Military Instructor (1992); MS, Naval Postgraduate School, 1992.

Arnold Herbert Buss, Visiting Assistant Professor, (1994); PhD, Cornell University, 1987.

George Conner, Senior Lecturer, Chair of Tactical Analysis, (1991); MS, Naval Postgraduate School, 1982.

Robert F. Dell, Assistant Professor (1990); PhD, State University of New York at Buffalo, 1990.

James Norfleet Eagle, II, Chairman of Undersea Warfare Academic Group, Professor (1982); PhD, Stanford University, 1975.

James Daniel Esary, Professor Emeritus (1970); PhD, University of California at Berkeley, 1957.

Robert Neagle Forrest, Professor Emeritus (1964); PhD, University of Oregon, 1959.

Donald Paul Gaver, Jr., Distinguished Professor (1970); PhD, Princeton University, 1956.

Eric Alexander Godat, LCDR, USN, Military Instructor, (1994); MS, Naval Postgraduate School, 1989.

Douglas Dean Grau, CDR, USN, Military Instructor, Curricular Officer, (1994); MS, Naval Postgraduate School, 1985, MA, Navy War College, 1993.

Thomas Eugene Halwachs, Lecturer; Director of Wargaming (1988); MS, Naval Postgraduate School, 1976.

John Hosford, LCDR USN, Military Instructor (1992); MS, Naval Postgraduate School, 1979.

Gilbert Thoreau Howard, Associate Professor and Director of Institutional Research (1967); PhD, Johns Hopkins University, 1967.

Chairman:
Peter Purdue (OR/Pd)
Glasgow Hall
Room 239
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DSN 878-2381

Associate Chairmen:

Operations
W. Kroshl (OR/Kb)
Glasgow Hall
Room 282
(408) 656-2493
DSN 878-2493

Research
Robert R. Read (OR/Re)
Glasgow Hall
Room 252
(408) 656-2382
DSN 878-2382

Instruction
L. Whitaker (OR/Wh)
Glasgow Hall
Room 256
(408) 656-3482
DSN 878-3482

- Wayne Philo Hughes, Jr.**, Senior Lecturer (1979); MS, Naval Postgraduate School, 1964.
- Patricia Anne Jacobs**, Professor (1978); PhD, Northwestern University, 1973.
- William Glenn Kemple**, Assistant Professor (1990); PhD, University of California at Riverside, 1985.
- William Mark Kroshl**, CDR, USN, Military Instructor (1994); MS, Naval Postgraduate School, 1988.
- Harold Joseph Larson**, Professor (1962); PhD, Iowa State University, 1960.
- Siriphong Lawphongpaich**, Associate Professor (1987); PhD, University of Florida, 1983.
- Peter Adrian Walter Lewis**, Distinguished Professor (1971); PhD, University of London, 1964.
- Judith Harris Lind**, Adjunct Professor (1985); MS, Naval Postgraduate School, 1985.
- Glenn Frank Lindsay**, Associate Professor (1965); PhD, Ohio State University, 1966.
- Kneale Thomas Marshall**, Professor and Chair of Emerging Technologies (1968); PhD, University of California at Berkeley, 1966.
- Alan Wayne McMasters**, Professor (1965); PhD, University of California at Berkeley, 1966.
- Paul Robert Milch**, Professor (1963); PhD, Stanford University, 1966.
- David Paul Morton**, National Research Center Associate (1993); PhD, Stanford University, 1993.
- Gordon Ross Nakagawa**, Lecturer, (1990); MS, Naval Postgraduate School, 1966.
- Samuel Howard Parry**, Professor (1964); PhD, Ohio State University, 1971.
- Frank Petho**, CDR USN, Assistant Professor, (1991); PhD, University of Vermont, 1979.
- George Prueitt**, LTC USA, Assistant Professor (1993); PhD, Auburn University, 1990.
- Peter Purdue**, Chairman and Professor (1986); PhD, Purdue University, 1972.
- Robert Richard Read**, Professor (1961); PhD, University of California at Berkeley, 1957.
- Richard Edwin Rosenthal**, Professor (1985); PhD, Georgia Institute of Technology, 1975.
- David Alan Schrady**, Professor (1965); PhD, Case Institute of Technology, 1965.
- Bruno Otto Shubert**, Associate Professor (1969); PhD, Stanford University, 1968.
- Tex Hawkins Shudde**, Professor Emeritus (1962); PhD, U.C. Berkeley, 1956.
- Jo Young Sohn**, Assistant Professor (1990); PhD, University of Pittsburgh, 1989.
- Michael Graham Sovereign**, Professor (1970); PhD, Purdue University, 1965.

James Grover Taylor, Professor (1968); PhD, Stanford University, 1966.

Robert Bruce Vassian, CDR, USN, Military Instructor (1994); MS, Naval Postgraduate School, 1991.

Alan Robert Washburn, Professor (1970); PhD, Carnegie Institute of Technology, 1965.

Lyn R. Whitaker, Associate Professor (1988); PhD, University of California, Davis 1985.

Roger Kevin Wood, Associate Professor (1982); PhD, University of California Berkeley, 1982.

Walter Max Woods, Professor (1962); PhD, Stanford University, 1961.

Mark Arthur Youngren, LTC, USA, Assistant Professor (1994); PhD, George Washington University, 1987.

Peter William Zehna, Professor Emeritus (1961); PhD, Stanford University, 1959.

* The year of joining the Naval Postgraduate School faculty is indicated in parentheses.

The Operations Research Department was founded in 1961 primarily to service students in the OA (360) Curriculum. Graduates of that curriculum receive the Master of Science in Operations Research degree as do graduates of the recently inaugurated Operational Logistics (361) Curriculum. The department consists of approximately forty faculty located in Glasgow Hall. The department operates two laboratories: the Human Systems Integration Lab located in Glasgow Hall and the Wargaming Lab in Ingersoll Hall.

In addition to being the primary department for the 360 and 361 curricula, the Operations Research Department also provides an extensive sequence of service courses for students in other curricula and is charged with teaching all probability and statistics courses at NPS. Nearly half of the department's teaching effort is devoted to these courses.

Active research areas within the department include statistics, stochastic processes, mathematical programming, human factors, wargaming, combat models, logistic systems, C3I systems, EW and ASW models, modeling and simulation

MASTER OF SCIENCE IN APPLIED SCIENCE

Students with acceptable academic backgrounds may enter a program leading to a degree in Applied Science with a major in Operations Research. The program of each student seeking this degree must contain a minimum of 20 quarter hours in operations research at the graduate level, including work at the 4000 level. Additionally, the program must contain a minimum of 12 graduate quarter hours in an approved sequence of courses outside the Department of Operations Research. A total minimum of 12 quarter hours at the 4000 level plus an acceptable thesis is required. This program provides depth and diversity through specially arranged course sequences to meet the needs of the Navy and the interests of the individual. The Department Chairman's approval is required for all programs leading to this degree. Applications to include this degree in dual master's programs will not be approved.

MASTER OF SCIENCE IN OPERATIONS RESEARCH

The degree Master of Science in Operations Research requires that:

1. A candidate shall previously have satisfied the requirements for the degree Bachelor of Science in Operations Research or the equivalent.
2. Completion of a minimum of 40 quarter hours of graduate level courses with:
 - a. At least 18 quarter hours of 4000 level operations research/systems analysis courses.

- b. An elective sequence approved by the Department of Operations Research.
- c. At least two, but not more than three, quarter courses devoted to a thesis. This credit shall not count toward the requirement as stated in (a) above.

Submission of an acceptable thesis on a subject previously approved by the Department of Operations Research.

DOCTOR OF PHILOSOPHY IN OPERATIONS RESEARCH

The department offers the Ph.D. degree in Operations Research. The program begins with advanced course work guided by the student's doctoral committee and leading to qualifying examinations in mathematical programming, statistics and stochastic processes, as well as completion of a minor field of study outside of operations research. The primary emphasis then shifts to the student's research program culminating in the Ph.D. dissertation.

Students wishing to enter directly into the doctoral program should write to the Department Chairman for detailed information on academic admission criteria. Applicants should include transcripts, Graduate Record Examination (or equivalent) scores and a brief statement of purpose. Detailed admission procedures may vary depending on the individual's location and position. However, in all cases the student must fulfill the general school requirements for the doctor's degree. Residency for this program generally requires two to three years beyond completion of a master's degree.

COURSE OFFERINGS

AR200 INTRODUCTION TO COMPUTATIONAL METHODS FOR OPERATIONS RESEARCH. (NO CREDIT) (2-2).

Introduction to the Naval Postgraduate School personal computer laboratories and software. DOS, editing, word processing, spreadsheets data analysis, database and presentation graphics will be introduced. Introduction to timesharing on the mainframe. PREREQUISITE: None.

A0001 SEMINAR FOR OPERATIONS ANALYSIS STUDENTS. (0-2).

Guest lecturers. Review of experience tours. Thesis and research presentations.

A0810 THESIS RESEARCH FOR OPS ANAL & LOGISTICS STUDENTS. (0-8).

Every student conducting thesis research will enroll in this course.

A2200 COMPUTATIONAL METHODS FOR OPERATIONS RESEARCH I (4-0).

First course in computer programming, with emphasis on the use of a higher level programming language directed toward computational methods particularly appropriate to operations research. Primary emphasis on the planning and structuring of computer programs. In-depth analysis of proper program logic flow, program listings and debugging techniques. Introduction to the mathematical and statistical subroutine libraries. Assigned projects involve file management, data structures and operations research models. PREREQUISITE: None.

A2600 INTRODUCTION TO OPERATIONS ANALYSIS. (4-0).

First course in Operations Analysis, covering its origins in World War II to current practice. Introduces concepts, tools and methods of analysis, with tactical examples. Emphasis is on measuring combat effectiveness and developing better tactics. PREREQUISITE: None.

A2900 WORKSHOP IN OPERATIONS RESEARCH / SYSTEMS ANALYSIS (7-0).

This course may be repeated for credit if course content changes. PREREQUISITE: Department approval. Graded on Pass/Fail basis only.

OA2910 SELECTED TOPICS IN OPERATIONS ANALYSIS. (V-0).

Presentation of a wide selection of topics from the current literature. This course may be repeated for credit if course content changes. PREREQUISITE: A background in operations research.

OA3101 PROBABILITY. (4-1).

Probability axioms and event probability. Random variables and their probability distributions. Moment generating functions, moments and other distribution characteristics, distribution families. Functions of a random variable, including the probability integral transformation. PREREQUISITE: MA1117 or equivalent.

OA3102 PROBABILITY AND STATISTICS. (4-1).

Jointly distributed random variables, independence and conditional distributions, covariance and correlation. Functions of several random variables, sampling distributions, limiting distributions, the central limit theorem, approximations. Order statistics, the t and F distributions, the bivariate normal distribution. Point estimation, properties of estimators. PREREQUISITES: OA 2200, OA 3101 and MA 1118 or equivalent; MA 3110 taken concurrently.

OA3103 STATISTICS. (4-1).

Confidence intervals, hypothesis testing, regression, analysis of variance, nonparametric inference. Applications to reliability, test and evaluation and operations research problems. PREREQUISITE: OA 3102 or equivalent.

OA3104 DATA ANALYSIS. (3-1).

Techniques of analyzing, summarizing, and comparing sets of real data. The exploratory nature of data analysis is featured through a variety of plotting methods and interactive work on computer terminals. Includes model building and the discovery and overcoming of shortcomings in data collected in actual situations. PREREQUISITE: OA 3103.

OA3105 NONPARAMETRIC STATISTICS. (4-0).

Tests based on the binomial distribution; confidence intervals for percentiles, tolerance intervals and goodness-of-fit tests; contingency tables; one sample tests, two sample tests and tests for independence based on ranks and scores; nonparametric analysis of variance and regression. Applications will illustrate the techniques. PREREQUISITE: A course in statistical inference.

OA3200 COMPUTATIONAL METHODS FOR OPERATIONS RESEARCH II. (4-0)

An advanced course in computer programming, with emphasis on the use of a higher level programming language directed toward computational methods particularly appropriate to operations research. Assigned projects involve advanced data structures operations research models, numerical analysis, data analysis, basic complexity analysis, and computer simulation. PREREQUISITE: OA2200, or consent of instructor.

OA3201 LINEAR PROGRAMMING. (Same as MA3301). (4-1).

Theory of optimization of linear functions subject to linear constraints. The simplex algorithm, duality, sensitivity analyses, parametric linear programming. Applications to resource allocation, manpower planning, transportation and communications, network models, ship scheduling, etc. Introduction to computer-based linear programming systems. PREREQUISITES: MA 2042, MA 3110, and OA 3200.

OA3301 STOCHASTIC MODELS I. (4-0).

The homogeneous and inhomogeneous Poisson processes, filtered and compound Poisson processes. Stationary Markov chains and their applications in modeling random phenomena. PREREQUISITE: OA3101 or consent of instructor.

OA3302 OA SYSTEM SIMULATION. (4-0).

Discrete event digital simulation methodology. Monte Carlo techniques, use of simulation languages. Variance reduction techniques, design of simulation experiments and analysis of results. PREREQUISITES: OA 3200 or equivalent, OA 3103 or equivalent, OA3301.

OA3401 HUMAN FACTORS IN SYSTEMS DESIGN I. (4-0).

The human element in man-machine systems. Selected topics in human engineering and psychophysics with emphasis on their relation to military systems. Man-machine interface and man's motor and sensory capacities. PREREQUISITE: A course in statistics.

OA3402 HUMAN FACTORS IN SYSTEMS DESIGN II. (3-0).

The human element in man-machine systems. Selected topics in human engineering and psychophysics with emphasis on their relation to military systems. Man-machine interface and man's motor and sensory capacities. PREREQUISITE: A course in statistics.

OA3501 INVENTORY I. (4-0).

A study of deterministic and approximate stochastic inventory models. Deterministic economic lot size models with infinite production rate, constraints, quantity discounts. An approximate lot size-reorder point model with stochastic demand. An approximate stochastic periodic review model. Single period stochastic models. Applications to Navy supply systems. PREREQUISITE: OA 3101 or consent of instructor.

OA3601 COMBAT MODELS AND GAMES. (4-0).

This course provides a discussion of measures of effectiveness and a quantitative introduction to dynamic programming, target coverage models, Kalman filters, Lanchester Systems, and two-person zero-sum games. PREREQUISITES: MA 3110, OA 3102.

OA3602 SEARCH THEORY AND DETECTION. (4-0).

Search and detection as stochastic processes. Characterization of detection devices, use and interpretation of sweep widths and lateral range curves, true range curves. Measures of effectiveness of search-detection systems. Allocation of search efforts, sequential search. Introduction to the statistical theory of signal detection. Models of surveillance fields, barriers, tracking and trailing. PREREQUISITES: OA 3101.

OA3610 INTRODUCTION TO NAVAL LOGISTICS (4-0).

Presentation of the fundamental purposes, history and components of the naval logistics system. Logistics is introduced as a command function necessary for sustaining combat operations. This concept is developed by looking at logistics resources and processes, unit and battle-group logistics, in-theater support, strategic lift, and CONUS/system support. PREREQUISITES: SECRET Clearance and approval of instructor.

OA3900 WORKSHOP IN OPERATIONS RESEARCH/SYSTEMS ANALYSIS. (V-0).

This course may be repeated for credit if course content changes. PREREQUISITE: Departmental approval. Graded on Pass/Fail basis only.

OA3910 SELECTED TOPICS IN OPERATIONS RESEARCH/SYSTEMS ANALYSIS. (V-0).

Presentation of a wide selection of topics from the current literature. This course may be repeated for credit if course content changes. PREREQUISITE: A background of advanced work in operations research. Consent of instructor.

OA4101 DESIGN OF EXPERIMENTS. (Same as MA4302). (3-1).

Theory and application of the general linear hypothesis model. Analysis of variance and analysis of covariance. Planning experiments, traditional and hybrid experimental designs. Use of standard computer packages for analysis of experimental data.

PREREQUISITE: OA3103 or equivalent.

OA4102 REGRESSION ANALYSIS. (Same as MA4303). (4-0).

Construction, analysis and testing of regression models. An in-depth study of regression and its application in operations research, economics and the social sciences. PREREQUISITES: OA3102, OA3103, and OA3104.

OA4103 ADVANCED PROBABILITY. (3-0).

Probability spaces, random variables as measurable functions, expectation using the Lebesgue-Stieltjes integral and abstract integration. Modes of convergence, characteristic functions, the continuity theorem, central limit theorems, the zero-one law. Conditional expectation. PREREQUISITE: MA 3605 or departmental approval.

OA4104 ADVANCED STATISTICS. (3-0).

Foundations of statistics from a decision-theoretic viewpoint. Robust estimation techniques, biased estimation. Fisher and Kullback information, asymptotic methods. sufficiency, completeness, the Cramer-Rao inequality. Sequential tests, empirical Bayes tests. Statistical computation methods. PREREQUISITE: OA 3103 and consent of instructor.

OA4201 NONLINEAR PROGRAMMING. (Same as MA4301). (4-0).

Introduction to modern optimization techniques, Karush-Kuhn-Tucker necessary and sufficient conditions for optimality, quadratic and separable programming, basic gradient search algorithms and penalty function methods. Applications to weapons assignment, force structuring, parameter estimation for nonlinear or constrained regression, personnel assignment and resource allocation. PREREQUISITE: OA 3201, MA 3110.

OA4202 NETWORK FLOWS AND GRAPHS. (4-0).

Introduction to formulation and solution of problems involving networks. Elements of graph theory, data structures, search algorithms, max-flow mincut theorem, shortest route problems, minimum cost flows, and PERT/CPM. Applications to production and inventory, routing, scheduling, network interdiction, and personnel management. PREREQUISITE: OA 3201.

OA4203 MATHEMATICAL PROGRAMMING. (4-0).

Advanced topics in linear programming, large scale systems, the decomposition principle, additional algorithms, bounded variable techniques, linear fractional programming, formulation and solution procedures for problems in integer variables. Applications to capital budgeting, large scale distribution systems, weapon systems allocation and others. PREREQUISITE: OA 3201.

OA4204 GAMES OF STRATEGY. (4-0).

Mathematical models of conflict situations, emphasizing the theory of decision making against a completely opposed enemy. Topics include matrix games, Blotto games, stochastic games, and the Shapley value. Applications to combat, resource allocation, cost sharing, etc. PREREQUISITES: OA 3201 and OA 3101 or consent of instructor.

OA4205 ADVANCED NONLINEAR PROGRAMMING. (4-0).

Continuation of OA 4201. Advanced topics in non-linear programming including duality theory, further consideration of necessary and sufficient conditions for optimality, additional computational methods examination of recent literature in non-linear programming. PREREQUISITES: OA 4201.

MA4206 DYNAMIC PROGRAMMING AND OPTIMAL CONTROL. (4-0).

The basic theory, including Bellman's equation and the Maximum Principle. Applications to tactical and economic problems. PREREQUISITE: OA 3201.

MA4301 STOCHASTIC MODELS II. (3-2).

Course objectives are to teach methods of stochastic modeling beyond those taught in OA 3301 and to give students an opportunity to apply these tools to real world problems. Suitably selected projects that entail data collection and analysis are undertaken, with emphasis on problem formulation, choice of appropriate assumptions and attainment of practical results. Topics include renewal processes, and further topics in queueing, illustrated by several military and industrial applications. PREREQUISITES: OA 3301, OA 3302, OA 104.

MA4302 RELIABILITY AND WEAPONS SYSTEM EFFECTIVENESS MEASUREMENT. (4-0).

Component and system reliability functions and other reliability descriptors of system effectiveness. Relationships between system and component reliability. Point and interval estimates of reliability parameters under various life testing plans. PREREQUISITE: OA 3301.

MA4303 SAMPLE INSPECTION AND QUALITY ASSURANCE. (4-0).

Attribute and variables sampling plans. MILSTD sampling plans with modifications. Multi-level continuous sampling plans and sequential sampling plans. Structure and implementation of quality assurance programs and analysis of selected quality assurance problems. PREREQUISITE: OA 3101 or consent of instructor.

MA4304 DECISION THEORY. (3-0).

Basic concepts, Bayes, admissible, minimax, and regret strategies. Principles of choice. Relation of statistical decision functions to the theory of games. Application in the planning of operational evaluation trials. PREREQUISITE: OA 3103.

MA4305 STOCHASTIC MODELS III. (4-0).

Lecture topics include, non-stationary behavior of Markov processes, point process models, regenerative processes, Markovian queueing network models, and non-Markovian systems. Applications to include reliability, computer system modeling, combat modeling and manpower systems. Students are given exercises entailing data analysis, formulation of probability models, and application of models to answer specific questions concerning particular phenomenon. PREREQUISITES: OA 3104, OA 3301, OA 4301.

MA4306 STOCHASTIC PROCESSES I. (4-0).

Selection of topics from the Kolmogorov theorem, analytic properties of sample functions, continuity and differentiability in quadratic mean, stochastic integrals, stationary processes, non-stationary processes, martingale limit theorems, the covariance principle, Markov and Gaussian processes. PREREQUISITE: OA 4103.

MA4307 STOCHASTIC PROCESSES II. (4-0).

Continuation of OA 4306. PREREQUISITE: OA 4306.

MA4308 TIME SERIES ANALYSIS. (Same as MA4304). (4-0).

Second order stationary processes. Harmonic analysis of correlation functions. Filters and spectral windows. Ergodic properties. Problems of inference in time series analysis. Box-Jenkins techniques. Introduction to the analysis of multivariate processes. PREREQUISITE: OA3301, OA3104.

MA4321 DECISION SUPPORT SYSTEMS. (3-1).

An introduction to the topic; includes an overview of organizational decision making, discussion of OR techniques integral to DDS, relationships to artificial intelligence and

expert systems, specialized computer languages, and non-traditional techniques for handling uncertainty. Current operational systems, both military and civilian, will be used as examples. PREREQUISITES: OA 3200 and OA 3101 or consent of instructor.

OA4333 SIMULATION METHODOLOGY. (4-0).

Advanced techniques of model development and simulation experimentation. Discussion of current research. Actual topics selected will depend on interest of students and Instructor. PREREQUISITE: OA 3302.

OA4401 HUMAN PERFORMANCE EVALUATION. (4-0).

Experimental considerations, strategy, and techniques in evaluation of human performance characteristics and capabilities. Detailed examination of special methods to include multivariate designs, psychophysiological methods. Review of important variables affecting human performance and criteria, measures of effectiveness, and figures of merit as indicants of performance quality. PREREQUISITE: OA 3401.

OA4402 SKILLED OPERATOR PERFORMANCE. (3-2).

First part of the course is devoted to an examination of the theoretical foundations of skilled performance. The second half of the course is devoted to the study of the acquisition, development and prediction of skilled operator performance in the operational setting. PREREQUISITE: OA 4401.

OA4404 OPERATIONS RESEARCH IN MAN-MACHINE SYSTEMS. (4-0).

Application of operations research techniques to man-machine design and evaluation problems. Quantitative methods for performance will be treated using such concepts as reliability, information theory, and signal detection theory. A portion of the course is devoted to summarizing approaches to real world problems incorporating current methods from the literature. PREREQUISITES: OA 3401, OA 3201, OA 3301, and OA 4301(may be taken concurrently).

OA4501 SEMINAR IN SUPPLY SYSTEMS. (4-0).

A survey of the supply system for the U.S. Navy. Topics include inventory models at all levels for consumables and repairables, budget formulation and execution, provisioning and allowance lists, planned program requirements, transaction item reporting and current topics of research such as stock migration, and material distribution studies. PREREQUISITE: OA 3501.

OA4502 INVENTORY II. (4-0).

A study of stochastic inventory models. Single period models with time dependent costs, constrained multiple item single period models, deterministic and stochastic dynamic inventory models, the periodic review model, the Q-1 continuous review model. PREREQUISITES: OA 3301, OA 3501.

OA4601 MODELS FOR DECISION MAKING (4-0).

The objective is to be able to formulate and analyze operational and executive decision problems, where a lack of clear problem definition and data, sequential timing of decisions, uncertainty, and conflicting objectives, are all normal features of such problems. Understanding and applying influence diagrams and decision trees form the core part of the course. Emphasis is on building models and determining data requirements. Specific areas include the use of policy space analysis in sensitivity analysis, the value of perfect information in evaluating the worth of a forecast, measuring outputs, and resolving decision conflicts that result from multiple output measures. PREREQUISITES: OA3201, OA3301.

OA4602 CAMPAIGN ANALYSIS. (4-0).

The development, use and state-of-the-art of maritime campaign analysis. Emphasis is on formulating the analysis, measures of effectiveness, handling assumptions, and parametric evaluations. Communicating results in speech and writing is an important

part of the course. Students conduct a project as study team members. They research and report on major portions of major U.S. Navy analyses. PREREQUISITES: OA 3103, OA 3302, OA 3601, OA 3602, OA 4604, and SECRET NOFORN clearance.

OA4603 TEST AND EVALUATION. (3-2).

This course relates the theory and techniques of operations research to the problems associated with test and evaluation. Specific examples of exercise design, reconstruction, and analysis are examined. PREREQUISITE: OA 3104.

OA4604 WAR GAMING ANALYSIS. (4-0).

Analysis of problems in the design, construction and application of manual, computer and interactive gaming. Emphasis is on gaming as a means of evaluating Naval Warfare tactics. Current naval/joint facilities will be used. PREREQUISITES: OA 3302 and SECRET NOFORN clearance.

OA4605 OPERATIONS RESEARCH PROBLEMS IN NAVAL WARFARE. (3-0).

Analysis of fleet exercises. Changes in tactics and force disposition arising from the introduction of nuclear weapons and missiles. Relationship of air defense to strike capability and ASW. Current radar, sonar, communications and ECM problems. PREREQUISITES: OA 3601, OA 4604.

OA4606 APPLICATIONS OF SEARCH, DETECTION AND LOCALIZATION MODELS TO ASW. (3-0).

Applications of search, detection and localization models to search planning, target localization and tracking procedures, and ASW sensor evaluation. Both acoustic and on-acoustic ASW sensors are considered. PREREQUISITES: OS 3601 or OA 4604. SECRET NOFORN clearance.

OA4607 TACTICAL DECISION AIDS (3-2).

In depth review of modern Naval Tactical Decision Aids, particularly those used in searching and tracking such as VPCAS, NODESTAR, and ASWTDA. Also includes an introduction to Kalman Filters. Principles of organization, computation, display, and test. Projects required. PREREQUISITES: OS2103/OS3604 or an equivalent Probability and Statistics sequence. Working knowledge of a programming language such as MATLAB, PASCAL, or C.

OA4608 SOVIET MILITARY OPERATIONS RESEARCH. (4-0).

This course provides an introduction to Soviet military operations research, with an emphasis on asymmetries in Soviet and American use of military OR. It will focus on how OR influences Soviet military theory and practice. It will begin by examining the Soviet military mind as influenced by the Russian/Soviet historical experience, Marxist-Leninist ideology, and Soviet social and military institutions. It will then trace the historical development of military OR in the Soviet Union and discuss its nature today. Students will receive English translations of major Soviet works on military OR. PREREQUISITES: Course on combat modeling (e.g. OA 3601 or OA 4654) or consent of instructor, and SECRET NOFORN clearance.

OA4610 MOBILIZATION. (4-0).

Introduction to the military and civilian systems for mobilization, linear programming and simulation formulations of strategic mobility and munitions scheduling. Planning and controls of the logistics systems, including planning factors and joint operations planning. Integration of mobilization with Navy operational logistics.

OA4611 LOGISTICS IN NAVAL WARFARE (4-0).

Presentation of the role of logistics and logisticians in war planning and strategy development with emphasis on jointness. Introduction to JCS, Unified and Navy command and staff structures and participation in deliberate and crisis action planning process. Emphasis on the transition to war, mobilization, strategic lift, and the weapon system acquisition process as related to logistics planning. PREREQUISITES: OA3610,

OA4612 LOGISTICS MODELS (4-0).

Mathematical modeling of most of the processes in unit/battle group or battle force logistics. Computation of fuel consumption, underway replenishment scheduling, shuttle ship requirements, measures of effectiveness, formations and their supportability, sustainability, engagement models and ordnance prediction, and implementation of such models in microprocessor-based logistics decision aids. Also ordnance programming models. Only for US students enrolled in curricula 360 or 361 only. PREREQUISITES: Consent of instructor.

OA4654 AIRLAND COMBAT MODELS I. (4-0).

Introduction to modeling air/ground combat operations with emphasis on detailed approaches for modeling small-scale combat. Topics include: types of models, the modeling process, verification, target acquisition models, target selection, weapon accuracy, lethality models, terrain effects, tactical decision making, and integration of these models into large scale simulation models of combat. Models currently in use in DOD analysis are used as examples throughout the course. PREREQUISITE: OA 3301

OA4655 AIRLAND COMBAT MODELS II. (4-0).

Modeling of large scale air/ground combat operations using aggregated force on force combat models. Topics include: Aggregation and disaggregation, types of models used for large scale operations, firepower index and Lanchester equation approaches to attrition modeling, movement rate of advance models, air warfare models, and air allocation, logistics, C3 I process models, artificial intelligence applications. Models currently in use for DOD analysis are used as examples throughout the course. PREREQUISITE: OA 3301 or consent of the instructor.

OA4701 ECONOMETRICS. (4-0).

Construction and testing of econometric models, analysis of economic time series, and the use of multivariate statistical analysis in the study of economic behavior. PREREQUISITE: OA 3103.

OA4702 COST ESTIMATION. (4-0).

Advanced study in the methods and practice of systems analysis with emphasis on cost analysis; cost models and methods for total program structures and single projects; relationship of effectiveness models and measures to cost analysis; public capital budgeting of interrelated projects; detailed examples from current federal practices. PREREQUISITE: AS 3610 or equivalent.

OA4703 DEFENSE EXPENDITURE AND POLICY ANALYSIS. (4-0).

A presentation of the major components of defense budgeting and policy formulation from the standpoint of the three major institutions involved, the agency, executive and congress. The use of quantitative models of institutional behavior is emphasized when examining both individual institutions and the interaction between them. PREREQUISITE: AS3610.

OA4704 O/R TECHNIQUES IN MANPOWER MODELING. (4-0).

The most frequently applied manpower models are studied including Markov chain and renewal models using grade and/or length of service categories. Statistical techniques to estimate relevant attrition and promotion rates from cohort and census data are also included in the course to provide both longitudinal and cross-sectional views of personnel systems. Career aspects are analyzed with respect to attrition, promotion opportunity and time to promotion in hierarchical systems with or without promotion zones. Examples emphasize the personnel systems of the military services. PREREQUISITES: OA 3201, 3301, and 3103.

MA4910 SELECTED TOPICS IN OPERATIONS ANALYSIS. (V-0).

resentation of a wide selection of topics from the current literature. This course may be repeated for credit if course content changes. **PREREQUISITE:** A background of advanced work in operations research and departmental approval.

MA4930 READINGS IN OPERATIONS ANALYSIS. (V-0).

This course may be repeated for credit if course content changes. **PREREQUISITE:** Departmental approval. Graded on Pass/Fail basis only.

MS2101 ANALYSIS OF EXPERIMENTAL DATA. (4-0).

Introduction to statistical analysis of measurements and experimental data. Frequency distributions, graphical representation. Populations and sampling. Principle of least squares, estimation of mean and standard deviation. Curve fitting and regression, propagation of errors. Confidence intervals, tests and contingency tables. Elementary NOVA. Relevant probabilistic concepts introduced as needed.

MS2102 INTRODUCTION TO APPLIED PROBABILITY FOR ELECTRICAL ENGINEERING. (4-1).

First course in probability. Structure of a probability model, density, distribution functions, expectation and variance. Some basic models, binomial, Poisson and Gaussian distributions. Conditional probability and independence. Joint distributions, covariance and central limit theorem. Transformations of random variables. **PREREQUISITE:** MA 1118 or equivalent.

MS2103 APPLIED PROBABILITY FOR SYSTEMS TECHNOLOGY. (4-1).

First course in probability for students in operational curricula. Topics include classical probability calculation, discrete and continuous random variables, basic probability distributions, introduction to modeling, expectation, variance, covariance and moments of discrete-time processes. Emphasis is on developing familiarity with basic concepts and computational skills rather than mathematical rigor. Problem session is used in part to refresh and reinforce necessary calculus topics. **PREREQUISITE:** MA 1118.

MS2210 INTRODUCTION TO COMPUTER PROGRAMMING. (4-1).

An introduction to the operation and programming of the mainframe computer and portable programmable computers used in the ASW Curriculum. The FORTRAN and BASIC languages are emphasized.

MS3001 OPERATIONS RESEARCH FOR COMPUTER SCIENTISTS. (4-0).

An introduction to some methodology and techniques of operations research that are relevant to computer system performance modeling and specification. Topics include Poisson processes, reliability theory and queueing theory.

MS3002 OPERATIONS RESEARCH FOR NAVAL INTELLIGENCE. (4-0).

This course provides an introduction to the approach and methods of operations research, with special emphasis on military applications of interest to intelligence. It focuses on the mathematical modeling of combat operations and considers intelligence aspects. Students develop basic skills in such modeling. Topics include: operational definitions, measurement of combat effectiveness, model validation/verification, and models versus modeling. Also included are modeling of processes of target acquisition, fire assessment (kill probabilities and target coverage), tactical decision making, and games.

MS3003 OPERATIONS RESEARCH FOR ELECTRONIC WARFARE. (4-0).

This course deals with applications of quantitative models to operational electronic warfare problems, with the underlying idea being to make decisions by optimizing some measure of effectiveness (MOE). Topics covered include ESM, ECM/ECCM, strike warfare. ASMD, and cost-effectiveness tradeoffs. **PREREQUISITES:** Calculus and MS2103.

OS3004 OPERATIONS RESEARCH FOR COMPUTER SYSTEMS MANAGERS.

(5-0). A one-quarter survey of operations research techniques of particular interest to students in computer systems management. Model formulation, decision theory, linear programming, project management techniques, inventory models, queueing and simulation, reliability and maintainability. Examples will illustrate the application of these techniques to the management of computer systems. PREREQUISITES: MA 2300, OS3101.

OS3005 OPERATIONS RESEARCH FOR COMMUNICATIONS MANAGERS. (4-0).

A one-quarter survey of operations research techniques of particular interest to students in communications management. Model formulation, decision theory, games, linear programming, network flows, CPM and PERT, reliability and maintainability, queueing theory, and systems simulation. PREREQUISITES: MA 2300, OS 3101 or OS 3105.

OS3006 OPERATIONS RESEARCH FOR MANAGEMENT. (4-0).

A survey of problem solving techniques for operations research. Topics include decision theory, linear programming, models, project scheduling, inventory, queueing and simulation. PREREQUISITES: MA 2300, OS 3101 or OS 3105.

OS3007 OPERATIONS RESEARCH METHODOLOGY. (4-0).

Survey of operations research techniques not covered in OS 3006. Topics may include simulation, search theory, extensions of combat models, network flows, and Markov chains. PREREQUISITES: OS 3106 and OS 3006 concurrently.

OS3008 ANALYTICAL PLANNING METHODOLOGY. (4-0).

A one-quarter survey of operations research techniques of particular interest to students in the C3 curriculum, with emphasis on model formation. Topics include linear and nonlinear programming, integer programming, networks, shop flow and project scheduling, decision analysis, queueing and simulation. PREREQUISITE: MA 2300.

OS3101 STATISTICAL ANALYSIS FOR MANAGEMENT. (4-1).

A specialized course covering the basic methods of probability and statistics with emphasis on managerial applications. The course includes applications of probability models, statistical inference and regression analysis. Computation for these applications are carried out on a computer, using commercial software packages. Topics in probability include the binomial, geometric, Poisson and normal distributions, risk and expected value. Parametric statistical techniques include significance testing and confidence intervals, together with point estimation of model parameters. Regression analysis includes simple linear regression and multiple regression, with estimation of parameters and tests of hypothesis and confidence intervals for regression coefficients and the variance of the error term. PREREQUISITE: College algebra.

OS3104 STATISTICS FOR SCIENCE AND ENGINEERING. (4-0).

Acquaint the engineering student with the techniques of statistical data analysis with examples from quality control, life testing, reliability and sampling inspection. Histograms and empirical distributions and random variables are introduced along with their probability distributions and associated characteristics such as moments and percentiles. Following a brief introduction to decision making, standard tests of hypotheses and confidence intervals for both one and two parameter situations are treated. Regression analysis is related to least squares estimation and associated tests of hypotheses and confidence intervals are treated. PREREQUISITE: Calculus.

OS3105 STATISTICAL ANALYSIS FOR MANAGEMENT I. (4-1).

The first of a two-quarter course in the use of the tools of probability and statistics oriented toward management applications. Skills in numerical computation are developed in laboratory periods through the use of MINITAB. Emphasis in the lectures is placed on modeling problems and interpreting results. Those aspects of probability

structure that are germane to distributions such as the binomial and normal. Standard topics of statistical inference for one and two variables are introduced in the settings of both hypothesis testing and confidence interval estimation. PREREQUISITE: MA 2300.

S3106 STATISTICAL ANALYSIS FOR MANAGEMENT II. (4-1).

The second of a two-quarter course in the use of the tools of probability and statistics oriented toward management applications. Using the tools and skills developed in OS 3105, the course consists of a general study of linear models, analysis of variance for one and two way models is followed by simple linear and multiple regression including such topics as curve fitting, residual analysis, and stepwise regression, along with correlation analysis. Again the computer is used as a tool to facilitate computations with emphasis on statistical packages for large data bases, such as SPSS and SAS. The course concludes with a sampling of nonparametric procedures. PREREQUISITE: OS 3105.

S3301 SYSTEMS EFFECTIVENESS CONCEPTS AND METHODS. (4-0).

An introduction to system reliability, maintainability, and effectiveness analysis. Failure (repair) rates and mean times to failure (repair). Models for aging and completion. Block diagrams and fault trees. Life testing, availability, interval reliability, and the synthesis of reliability, maintainability, and effectiveness analysis. PREREQUISITES: OS 3105, OS 3106.

S3302 QUALITY ASSURANCE AND RELIABILITY. (4-0).

A technical treatment of quality assurance discipline with attention to its corresponding programmatic and managerial elements. Survey of current trends and policies in total quality management and system design, development and production and logistic support. Reliability modeling, testing, growth, estimation and assessment, manufacturing qualification, process control management and improvement, quality control charts. Survey of selected current DOD instructions, handbooks and manuals.

S3303 COMPUTER SIMULATION. (4-1).

Design, implementation and use of digital simulation models will be covered with special emphasis on features common to ASW problems. War gaming will be discussed and a game using the digital computer will be played and critiqued by the class. Exercise planning and analysis will be treated. Basic topics are explained including computer generation of random variates, statistical design and monitoring of model progress, machine representation of dynamic data structures, model verification and validation on special purpose simulation and gaming languages. PREREQUISITES: OS 3603, OS 3604 or equivalent, and a working knowledge of FORTRAN programming.

S3401 HUMAN FACTORS ENGINEERING. (3-0).

An introduction to human factors engineering for students in fields such as engineering. Designed to give the student an appreciation of man's capacities and limitations and how these can affect the optimum design of the man-machines system. Emphasis on integration of human factors into the system development cycle considering such topics as manpower/personnel costs, control and display design, human energy expenditure, physiological costs, and evaluation systems. PREREQUISITE: A previous course in probability and statistics.

S3402 HUMAN FACTORS FOR ANTISUBMARINE WARFARE (3-1).

This course involves an examination of man's attentiveness and capability in the detection of changes in stimulus events over prolonged periods of observation. Topics to be covered include theories of vigilance; task, signal, subject and environmental influences on performance, physiological and psychological responses and vigilance performance measurement. This course is designed for the ASW curriculum. PREREQUISITE: OS 3603 or equivalent.

OS3403 HUMAN FACTORS IN ELECTRONIC WARFARE. (3-1).

This course will provide the student with the ability to evaluate and predict human performance in specified operational environments. The effects of stress factors such as noise, temperature, motion, work load, etc., on various aspects of human performance will be studied. Students will identify the control and display requirements of an EW system and design a workspace to accommodate an EW data reduction/analysis system. **PREREQUISITE:** OS 3604.

OS3404 MAN-MACHINE INTERACTION. (3-2).

An introduction to the man-machine interface problems in C3. Information, display and human communication requirements for effective C3. Applied orientation involving message handling systems, query languages, computer computer communications, command and control applications programs, file transfer between host computers, etc. **PREREQUISITE:** Enrollment in C3.

OS3601 SEARCH, DETECTION, AND LOCALIZATION MODELS. (4-0).

An introduction to the decision problems associated with Navy detection systems. The relation of detection models to search and localization models measures of effectiveness of search/detection systems, and the optimum allocation of search effort are discussed. This course is designed for the ASW curriculum. **PREREQUISITES:** OS 2103, PH 2401 or consent of instructor, and SECRET clearance.

OS3602 ASW COMBAT ANALYSIS (4-0).

This course deals with the analysis of ASW operations. Topics include the analysis of force integration and communications, combat attrition, system reliability, target tracking, target data fusion and system measures of effectiveness. The course is designed for the ASW curriculum. **PREREQUISITES:** OS2103 and OS3601 or consent of instructor.

OS3603 SIMULATION AND WAR GAMING. (3-1).

Design, implementation and use of digital simulation models will be covered with special emphasis on features common to C3 and EW problems. War gaming will be discussed and a game using the digital computer will be played and critiqued by the class. Exercise planning and analysis will be treated. Basic topics are explained including computer generation of random variates, statistical design and monitoring of model progress, machine representation of dynamic data structures, model verification and validation on special purpose simulation and gaming languages. **PREREQUISITES:** OS 2103, OS 3604 or equivalent, and a working knowledge of FORTRAN programming, and SECRET clearance.

OS3604 DECISION AND DATA ANALYSIS. (4-0).

This course provides an introduction to the techniques of decision analysis, statistics and data analysis. It is primarily for students in the ASW, EW and C3 curricula. Emphasis is placed on the analysis of data and decision making in the ASW, EW and C3 environments. **PREREQUISITES:** OS 2103 or equivalent.

OS3636 ARCHITECTURE OF C3I SYSTEMS. (4-0).

This course is primarily intended for students in the command and control program. It provides an introduction to the evaluation and modeling of command-control-communications-and intelligence (C3I) systems, with an emphasis on the comparative anatomy of Blue and Red systems and operational intelligence. The student is introduced to concepts pertaining to the design, functioning, and evaluation of such large-scale systems and their architecture. **PREREQUISITES:** U.S. citizenship and TO SECRET clearance with eligibility for SBI.

OS3637 SOVIET OPERATIONS AND SYSTEMS. (4-0).

This course is intended for students in any of the operational curricula (but primarily the C3 program). It provides an introduction to Soviet thinking, conceptualization of

ilitary affairs, systems, and operations. Soviet control concepts, including troop control, control of combat means, and the role of automation, are emphasized. The systems approach to integrating different types of intelligence data to support U.S. defense (including command) decision making is considered. The course stresses the understanding of Soviet key words and concepts in military affairs. PREREQUISITES: U.S. citizenship and TOP SECRET clearance with eligibility for SI/SAO.

S3702 MANPOWER REQUIREMENTS DETERMINATION. (4-0).

The objective is to enable the student to use some of the tools of industrial engineering in the determination of the quantity and quality of manpower required in military systems. Techniques include motion and time study, work sampling, predetermined time standards, work design and layout, materials handling, procedures review and process design. Applications for ship and squadron manning documents and FORESTAMPS are included. PREREQUISITES: OS 3006, or OA 3201 and OA 3301.

S4601 TEST AND EVALUATION. (4-0).

Designed for system technology students, this course examines problems associated with tests and evaluations of weapon systems and tactics. Included are concepts from experimental design, regression analysis. Realistic data sets and examples are discussed and analyzed. PREREQUISITE: Inferential statistics.

S4602 C3 SYSTEMS EVALUATION. (2-4).

This course is designed for Systems Technology students in the Command, Control and Communications Curriculum. The course deals with techniques for the design, implementation and analysis of experiments or exercises aimed at the test and evaluation of systems, tactics, or operational concepts. Course topics include modeling, experimentation methodology, design of experiments, multi-criteria decision analysis, reliability, and man-machine interaction. Case studies and real data will be examined and students will actively participate in evaluations through laboratory experiments. PREREQUISITES: OS 3008, OS 3603, OS 3604, SECRET NORFORN clearance.

S4701 MANPOWER AND PERSONNEL MODELS. (4-0).

The objective of this course is to introduce the student to the major types of manpower and personnel models for estimating the effects of policy changes on the personnel system. Topics include longitudinal and cross-section models, optimization models, data requirements and validation. Applications in the form of current military models are included. PREREQUISITES: OS 3006, and OS 3106.

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Xavier K. Maruyama, Professor (1987); PhD, Massachusetts Institute of Technology, 1971.

Richard Christopher Olsen, Associate Professor (1987); PhD, University of California at San Diego, 1980.

James Vincent Sanders, Associate Professor (1961); PhD, Cornell University, 1961.

Gordon Everett Schacher, Professor (1964); PhD, Rutgers, 1961.

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Joseph Sternberg, Professor (1985); PhD, John Hopkins University, 1955.

Robert Louis Armstead, Associate Professor (1964)*; PhD, University of California at Berkeley, 1964.

Anthony A. Atchley, Associate Professor (1985); PhD, University of Mississippi, 1985.

Steven Richard Baker, Associate Professor (1985); PhD, University of California at Los Angeles, 1985.

David Dempster Cleary, Assistant Professor (1988); PhD, Colorado, 1985.

William Boniface Colson, Chairman and Professor (1989); PhD, Stanford University, 1977.

Alfred William Madison Cooper, Professor (1957) PhD, The Queen's University of Belfast, 1961.

David Scott Davis, Associate Professor (1989); PhD, Purdue University, 1976.

Steven Lurie Garrett, Professor (1982); PhD, University of California at Los Angeles, 1977.

Suntharalingam Gnanalingam, Senior Lecturer (1985); PhD, Cambridge University, 1954.

Richard M. Harkins, Instructor (1994), MS, Naval Postgraduate School, 1988.

Dan Howard Holland, Senior Lecturer (1990); PhD, Stanford University, 1955.

Ronald Lee Walters, Associate Professor (1983); PhD, Kansas State University, 1971.

Karlheinz Edgar Woehler, Professor (1962); PhD, University of Munich, 1962.

William Bardwell Zeleny, Associate Professor (1962); PhD, Syracuse University, 1960.

The year of joining the Naval Postgraduate School faculty is indicated in parentheses.

Expertise in the Department of Physics and efforts in research and teaching of graduate specialization courses for the last twenty years can be summarized under the heading "physics of propagation phenomena in realistic, complex environments". Specialized course sequences are offered in the following areas:

- Optical Signal Propagation and Detection.
- Directed Energy Weapons Systems.
- Nuclear Weapons and their Effects.
- Underwater Acoustics.
- Physics of the Space and Satellite Environments.
- Simulation of Large Scale Systems.
- Physical Acoustics.

All of these specializations are of obvious relevance to modern and future weapons technologies. The faculty supports an ongoing research program in these areas and student thesis topics are available in all of them.

DEGREE REQUIREMENTS

The Department of Physics offers the Master of Science and the PhD degrees in Physics and in Applied Physics. Upon approval by the department, courses taken at other institutions may be applied toward satisfying degree requirements.

MASTER OF SCIENCE IN PHYSICS

A candidate for the degree Master of Science in Physics must complete satisfactorily a program of study which includes a minimum of 30 quarter hours of physics courses (not including thesis) distributed among courses at the graduate (3000 or 4000) level; of these 30 hours at least 15 hours must be at the 4000 level. Upon approval of the chairman of the Physics Department, a maximum of 4 hours of courses taken in another department may be applied toward satisfying the above requirements. In lieu of the preceding requirements, students who are qualified to pursue graduate courses in physics when they arrive at the Naval Postgraduate School may complete a minimum of 30 hours entirely of 4000 level physics courses. In addition, all students must satisfy the general Postgraduate School minimum requirements for the master's degree and present an acceptable thesis.

The following specific course requirements must be successfully completed for a student to earn the degree Master of Science in Physics:

- PH3152: Mechanics II - Extended Systems,
- PH3352: Electromagnetic Waves,
- PH3991: Physics of Oscillations and Waves II,
- PH3782: Thermodynamics and Statistical Physics.
- PH4353: Topics in Advanced Electricity and Magnetism
- PH4984: Advanced Quantum Physics

or equivalents to the above courses.

In addition to the above, a graduate sequence containing at least two Physics courses, at least one of which must be at the 4000 level.

All programs leading to the degree Master of Science in Physics must be approved by the Chairman of the Department of Physics.

MASTER OF SCIENCE IN APPLIED PHYSICS

To be awarded the degree Master of Science in Applied Physics, a student must complete a program of study which includes at least 32 quarter hours of courses (not including thesis) at the graduate (3000 or 4000) level. Of these 32 hours, at least 15 hours must be at the 4000 level. Subject to the approval of the Chairman of the Department of Physics, a maximum of 40% of the hourly requirements in each of these categories may be taken outside the Physics Department in technical subjects related to Physics. The remaining 60% in each category must consist of Physics courses.

As part of the above requirements, a student's program must include an area of graduate concentration, containing at least four graduate courses approved by the Chairman of the Department of Physics. At least two of these courses must be at the 4000 level.

To be eligible for the degree Master of Science in Applied Physics, a student must demonstrate adequate knowledge of basic electromagnetism and of the fundamentals of quantum physics. This requirement can be met by passing an examination or by successfully completing a physics course at the Naval Postgraduate School in each of these areas.

All programs leading to the degree Master of Science in Applied Physics must satisfy the general Postgraduate School minimum requirements for the Master's degree, must include an acceptable thesis, and must be approved by the Chairman of the Department of Physics.

DOCTOR OF PHILOSOPHY

The Department of Physics offers the PhD. degree in several areas of specialization which currently include acoustics, electro-optics, free electron lasers, space physics, theoretical physics, and nuclear physics.

Requirements for the degree may be grouped into three categories: courses, dissertation research, and examinations in major and minor fields.

The required examinations are outlined under the general school requirements for the PhD. In particular, the Department requires a preliminary examination to show evidence of acceptability as a doctoral student. This examination may be taken before or after commencement of graduate studies at NPS.

The department offers two options for the PhD. ; major in Physics or major in Applied Physics. For the major in Physics, a minimum of 40 credit hours of physics courses at the 4000 level is required. The major in Applied Physics also requires 40 credit hours of 4000 level courses, but a portion of these hours may be taken in other departments in technical subjects related to physics. For either of these options, additional courses are required in the minor field of study.

A more detailed description of departmental requirements for the PhD. is contained in the booklet "Doctoral Study in Physics or in Applied Physics at the Naval Postgraduate School."

An applicant to the PhD program who is not already a student at NPS should submit transcripts of previous academic and professional work, plus results of a current Graduate Record Examination (GRE) general test, to the Director of Admissions, Code 62, Naval Postgraduate School, Monterey, California 93943-5100.

PHYSICS LABORATORIES

The physics laboratories are equipped to carry on instruction and research work in atomic physics, nuclear physics, electro-optics, plasma physics, spectroscopy and acoustics.

The 100 MeV electron linear accelerator provides a pulsed electron beam of one microampere average current and is used for radiation studies. This machine is augmented by a Pulserad 112 single pulse electron accelerator producing a 1.8 MeV, 40 loampere beam of 50 nanosecond duration. Both machines are suitable for studies of radiation effects in semiconductor devices and electromagnetic pulse generation.

The Electro-Optics Laboratory uses imaging and detecting systems from the far infrared to the visible range including instrumentation for seagoing experiments in optical propagation. The Laser Laboratory contains a giant pulse laser and associated detection equipment for the visible spectrum as well as a high power laser in the IR region.

The Acoustics Laboratory equipment includes a large anechoic chamber, a small reverberation chamber and a multiple-unit acoustics laboratory for student experimentation in airborne acoustics. Sonar equipment, test and wave tanks and instrumentation for investigation in underwater sound comprise the underwater acoustics laboratory. The physical acoustics laboratories are equipped with a variety of modern data collection and processing equipment.

COURSE OFFERINGS

HR110 REFRESHER PHYSICS. (NO CREDIT). (5-3).

This course meets the last 6 weeks of the quarter. Selected topics from elementary physics for incoming students. Typical topics are kinematics, Newton's Laws of motion, work, energy linear and angular momentum, basic concepts of fluid flow, temperature, heat and the kinetic theory of gases. Vector algebra and some aspects of calculus are developed as needed and their use is emphasized. The two ninety-minute problem sessions are devoted to guided problem solving. Prerequisites: Previous college course in elementary physics and integral calculus. Refresher Mathematics (calculus) is usually taken concurrently.

H0499 ACOUSTICS COLLOQUIUM. (NO CREDIT) (0-1).

Reports on current research, and study of recent research literature in conjunction with the student thesis. **PREREQUISITE:** A course in acoustics.

H0810 THESIS RESEARCH. (0-8).

Every student conducting thesis research will enroll in this course.

H0999 PHYSICS COLLOQUIUM. (NO CREDIT) (0-1).

Discussion of topics of current interest by NPS and outside guest speakers.

H1001 PHYSICS REFRESHER: MECHANICS (4-2).

This is the first of a two course sequence for students entering the Combat Systems Science & Technology Curriculum. This course meets twelve hours a week for lectures and problem sessions for the first six weeks of the quarter. Topics covered are: motion in one, two, and three dimensions; force and Newton's law; particle dynamics; work and energy; conservation of energy; systems of particles; rotational kinematics and dynamics; angular momentum; oscillations; gravitation; fluid dynamics and wave motion.

H1002 PHYSICS REFRESHER: ELECTRICITY AND MAGNETISM (4-2).

This is the second of a two course sequence for students entering the Combat Systems Science & Technology Curriculum. This course meets twelve hours a week for lectures and problem sessions for the last six weeks of the quarter. Topics covered are: Coulomb's law; the electric field; Gauss' law; electric potential; capacitance; current and resistance; DC circuits; the magnetic field; Ampere's law; Faraday's law; magnetic properties of matter; inductance; AC circuits; Maxwell's equations; and electromagnetic waves. **PREREQUISITE:** PH1001.

PH1121 MECHANICS. (4-2).

Vector algebra, particle kinematics in one and two dimensions, Newton's laws of motion, particle dynamics, work and energy, conservation of energy, systems of particles, conservation of momentum, rotational kinematics and dynamics, gravitation, simple harmonic motion, basic concepts of fluid motion, temperature, heat and kinetic theory of gases. PREREQUISITES: A course in calculus or concurrent registration in a calculus course.

PH1322 ELECTRICITY AND MAGNETISM. (5-0).

Electric charge, Coulomb's Law, electric field, Gauss' Law, electrical potential and energy, capacitors and dielectrics, current and resistance, EMF and DC circuits, magnetic field, Ampere's Law, Faraday's Law, inductance. Additional topics may include electromagnetic oscillations, Maxwells equations, electromagnetic waves, conduction of electricity in solids. PREREQUISITE: PH1121 or equivalent.

PH2001 PHYSICS THESIS OPPORTUNITIES. (1-0).

This course is designed for students interested in choosing and pursuing a Master's thesis in physics. Members of the faculty of the Department of Physics having research projects suitable for Master's degree theses will give presentations on their projects. The course is given in the pass/fail mode. PREREQUISITE: At least 7 quarter-hours of physics courses.

PH2119 OSCILLATION AND WAVES. (4-2).

An introductory course designed to present mechanics to students studying acoustics. Kinematics, dynamics, and work and energy consideration for the free, damped, and driven oscillators. The wave equation for transverse vibration of a string, ideal and realistic boundary conditions, and normal modes. Longitudinal and transverse waves in bars. Transverse waves on rectangular and circular membranes. Vibrations of plates. Laboratory periods include problem sessions and experiments on introduction to experimental techniques and handling of data; the simple harmonic oscillator analog; transverse waves on a string; and transverse, longitudinal, and torsional waves on a bar. PREREQUISITE: Courses in differential equations and basic physics.

PH2151 PARTICLE MECHANICS. (4-1).

After a review of the fundamental concepts of kinematics and dynamics, this course concentrates on those two areas of dynamics of simple bodies which are most relevant to applications in Combat Systems: vibrations and projectile motion. Topics include: damped and driven oscillations, projectile motion with atmospheric friction, satellite orbits, and rotating coordinate systems. PREREQUISITE: PH 1121 or equivalent; MA 2121 or equivalent course in ordinary differential equations (may be concurrent).

PH2203 TOPICS IN BASIC PHYSICS: WAVES AND OPTICS. (4-0).

A course to provide physical background to wave motion, acoustics, and optics for students in the Electronic Warfare Curriculum, and to provide applications of analytical techniques to physical problems. Areas covered are harmonic motion-differential equations, complex notation, damped vibration and resonance; wave motion (properties of waves, sound waves, optics), geometrical and wave optics. PREREQUISITES: MA 2138, MA 2047; may be taken concurrently.

PH2207 FUNDAMENTALS OF ELECTRO-OPTICS. (4-0).

This course is designed to provide students in interdisciplinary curricula with specific prerequisite background for electro-optics courses in those curricula. Topics discussed include: matrix formulation of optics, catoptric and catadioptric systems, diffraction, behavior of gaussian profile beams, Fourier optics and resolution, atmospheric transmission, atomic and molecular energy states, line shapes, band theory of

emiconductors, the p-n junction, light emitting diodes, stimulated emission, and lasers. PREREQUISITES: MA 3139 and and PH2203 (or equivalent).

PH2351 ELECTROMAGNETISM. (4-1).

Electrostatic fields in vacuum and dielectrics, electrostatic energy and capacitors. The magnetic field of steady currents, Biot-Savart and Ampere's Laws, vector potential, magnetic properties of matter. Faraday's Law. Magnetic energy. Maxwell's Equations. Gauge transformations. The electromagnetic wave equation and plane waves. Prerequisites: PH1322 or equivalent and PH2990.

PH2401 INTRODUCTION TO THE SONAR EQUATIONS. (3-0).

Discussion of each term of the sonar equations, with application to the detection, localization, and classification of underwater vehicles. Topics include ray acoustics, simple transmission loss models, tonals, spectrum and levels, directivity index, array gain, doppler shift, and detection threshold. This course is intended primarily for students in the Undersea Warfare curriculum and is given in a structured" PSI mode. PREREQUISITE: Calculus mathematics.

PH2410 ANALOG ELECTRONICS AND SIGNAL CONDITIONING FOR ACOUSTICS (3-2).

Applications of simple integrated circuits to acoustical measurements including op-amp filters and amplifiers, voltage controlled oscillators, D-to-A, A-to-D, and frequency-to-voltage converters. Sources of noise (thermal and quantization) in electro-acoustic systems. Techniques of noise reduction in the frequency and time domains including signal integration and time averaging, digital and analog Fourier analysis, phase sensitive detection and the domain auto- and cross-correlation analysis. PREREQUISITES: SE2012 and EC2170.

PH2511 INTRODUCTION TO ORBITAL MECHANICS. (4-0).

The gravitational two-body problem. Elliptic orbits and orbital elements. Orbital maneuvers and transfers. Time of flight. Ground track. Additional topics selected from the following: suborbital trajectories, hyperbolic trajectories, orbit determination from radar data, sun synchronous orbits, Molniya orbits and orbital perturbations. PREREQUISITES: A course in basic mechanics (including vectors) and a course in ordinary differential equations.

PH2514 INTRODUCTION TO THE SPACE ENVIRONMENT (4-0).

Plasma concepts. Solar structure and magnetic field, particle and electromagnetic emissions from the sun, the geomagnetic field, and the magnetosphere; radiation belts, structure and properties of the earth's upper atmosphere, ionosphere, implications of environmental factors for spacecraft design. PREREQUISITE: A course in basic electricity and magnetism.

PH2601 SURVEY OF MODERN PHYSICS (4-1).

This is a one term course covering the fundamentals of modern physics with selected applications. Topics include special relativity, the wave-particle duality, the Schrodinger equation, atoms and molecules, lasers, semiconductors, and superconductors. PREREQUISITES: PH1322.

PH2724 THERMODYNAMICS. (4-0).

Equations of state; the concepts of temperature, heat and work; the first law of thermodynamics; heat engines and refrigerators; entropy and the second law of thermodynamics; thermodynamic potentials; phase equilibrium; kinetic theory; equipartition theorem; transport phenomena. PREREQUISITES: PH 1121 and a course in multivariable calculus.

PH2911 INTRODUCTION TO COMPUTATIONAL PHYSICS. (3-2).

An introduction to the role of computation in modern physics with emphasis on the programming of current nonlinear physics problems and the use of graphics. Includes an introduction to C programming language as well as the UNIX and DOS operating systems. Subject matter includes projectile trajectories with air drag, nonlinear celestial mechanics, damped and driven nonlinear oscillators, molecular dynamics in solids, liquids and gases, and numerical integration methods. **PREREQUISITE:** A basic physics course.

PH2990 PHYSICS OF OSCILLATIONS AND WAVES (4-0).

Vector analysis including line integrals, Stokes theorem, and divergence theorem. Application to physical concepts including fluid flow, conservative fields, scalar and vector potentials. Complex algebra applied to resonance and impedance in complex circuits as well as one-dimensional waves (string, sound, and electromagnetic). Interference and diffraction. Separation of variables for partial differential equations in Cartesian coordinates. Theory of complex functions and contour integration. Fourier series with applications to normal modes, spectral power distribution (e.g. pulse-Doppler radar), phase and group speeds. **PREREQUISITES:** Multivariable calculus, ordinary differential equations.

PH3001 UNDERSEA WARFARE SENSORS I (4-0).

This course will be followed by U.W. WARFARE SENSORS II eff Sum '95.

PH3002 NON-ACOUSTIC SENSOR SYSTEMS. (4-0).

This course covers the physical principles underlying the operation of a number of operational and proposed non-acoustic sensor systems. Geomagnetism, magnetometers and gradiometers, MAD signatures, optical and IR transmission in the atmosphere and in sea water. Image Converter, FLIR and radar systems for ASW. Exotic detection schemes. **PREREQUISITES:** PH3360, EO3720, SECRET clearance.

PH3052 REMOTE SENSING FOR U.W. AND C3. (4-0)**PH3152 MECHANICS OF PHYSICAL SYSTEMS. (4-0).**

The dynamics of rockets. Rotating coordinate systems and coriolis acceleration. Hamilton's principle and the role of physical symmetry in dynamics. Velocity dependent potentials. The inertia tensor and the rotational dynamics of rigid bodies. Small oscillations and normal **PREREQUISITE:** PH2151.

PH3161 FLUID DYNAMICS. (4-1).

This course emphasizes the dynamics of real compressible fluids. The basic properties of fluids are introduced and the concepts of fluid kinematics, stress, and strain are discussed. Both the control volume and differential equation approaches are applied to the flow of viscous fluid. The laws of similarity are developed, and the significance of Reynolds, Froude, and Mach number discussed. Topics covered include, laminar and turbulent flow, isentropic subsonic channel flow, supersonic flow in nozzles, and two-dimensional supersonic flow. **PREREQUISITE:** PH 2151 or equivalent.

PH3171 EXPLOSIVES AND EXPLOSIONS (4-0).

Thermodynamics and thermochemistry of explosive decomposition; detonation and fireball; Rankine-Hugoniot relations; normal and oblique reflection; Mach stem; explosive strength; blast wave profile; propagation and reflection of the blast wave in air; properties of selected explosives; scaling laws; safety distances; underwater explosions; shaped charges. **PREREQUISITE:** PH2151

PH3172 FLUID DYNAMICS OF WEAPONS. (4-1).

This course is designed for the officers in the Combat Systems Sciences and Technology Curriculum to provide the basic physical principles applicable to air-borne and water-borne missiles. Topics include: the stress tensor and the rate of deformation tensor. The general equations of continuity, momentum, and energy. Navier-Stokes equation for incompressible flow. Laminar boundary layers. Hydrodynamic stability and the turbulent boundary layer. Drag and lift in incompressible flow with application to torpedoes. Normal and oblique shock waves. Supersonic nozzles. drag and lift of supersonic airfoils with application to missiles. PREREQUISITE: PH3171.

PH3200 SURVEY OF ELECTRO-OPTIC DEVICES AND SYSTEMS. (4-0).

A survey of the physical principals and capabilities of military electro-optic and infrared systems for students in the Combat Systems Sciences and Technology Curriculum not enrolled in the Electromagnetic Concentration. Topics treated include: source and background radiant signatures, atmospheric propagation effects, detector mechanisms, types and characteristics; categorization of military EO/IR systems; trackers, TV and low light television, night vision devices, line scanners, forward looking infrared and infrared search and track; scanning and staring focal plane array systems; active range finders, laser target designators and LIDAR; systems analysis, constraints and the range equation; active and passive countermeasure techniques; emerging technologies and future trends. PREREQUISITES: PH3991, PH3292, PH3653, or equivalent.

PH3208 ELECTRO-OPTIC PRINCIPLES AND DEVICES (4-1).

This course is designed to provide students in inter-disciplinary programs with a general understanding of the principles and capabilities of the component devices comprising military electro-optic and infrared systems. Topics treated include: atmospheric extinction, turbulence, thermal blooming and breakdown, adaptive optics, thermal radiation, target signatures, backgrounds, electro-optic and acousto-optic devices, reticles and other trackers, detector characteristics, noise and cooling, television, CCD, CID and scanning imagers. Laboratory work provides hands-on familiarity with these devices. PREREQUISITES: PH2203, PH2207, MA3139 or equivalent.

PH3252 ELECTRO-OPTICS. (4-0).

This course treats the properties of electro-optic systems together with the basic physical principles involved. Topics included are: diffraction and Fourier transform methods; optical data processing; Fresnel equations, evanescent waves, film and fiber optics; Gaussian beams and laser resonators; molecular spectra, transition probability, line widths, and laser gain; specific lasers, Q-switching and mode locking; semi-conductors, junction diodes, photodetection, light emitting diodes and diode lasers. PREREQUISITES: PH3352, PH3652.

PH3292 OPTICS AND OPTOELECTRONICS (4-1).

An introduction to the basic principles of optics and optoelectronics. Geometrical optics: reflection and refraction at surfaces, mirrors, lenses, image formation, aberrations, matrix analysis of optical systems. Physical optics: multiple-beam interference, Fraunhofer and Fresnel diffraction, spatial and spectral resolution, electromagnetic wave equation, polarization. Radiometry, fiber optics, blackbody radiation, introduction to optoelectronic detectors and lasers. PREREQUISITE: PH2990 or equivalent.

PH3352 ELECTROMAGNETIC WAVES AND RADIATION (4-0).

Propagation of uniform plane waves in free space, in dielectric media, in conducting media (with emphasis on sea water), and in the ionosphere. Reflection and refraction. Radiation and antennas. Principles of radar. Rectangular waveguides. PREREQUISITE: PH2351.

PH3360 ELECTROMAGNETIC WAVE PROPAGATION. (4-1).

Introduction to vector fields and the physical basis of Maxwell's equations. Wave propagation in a vacuum, in dielectrics and conductors, and in the ionosphere. Reflection and refraction at the interface between media. Guided waves. Radiation from a dipole. PREREQUISITES: MA 2121 and a course in basic electricity and magnetism.

PH3400 SURVEY OF UNDERWATER ACOUSTICS (4-2).

The physics of the generation, propagation, and detection of sound in the ocean. Topics include: The acoustic wave equation and its limitations in fluids; plane, cylindrical, and spherical waves; the ray approximation. Reflection of plane waves from plane boundaries. Radiation of sound from circular piston, continuous line source, and linear array. Speed of sound and absorption in the ocean. Active and passive sonar equations transmission-loss and detection-threshold models. Normal mode propagation in the ocean. The parabolic equation approximation. Laboratory experiments include surface interference, noise analysis, normal modes, and acoustic waveguides. PREREQUISITES: PH2151 and PH3991.

PH3410 OPTICAL FIBER SENSORS AND COMMUNICATION SYSTEMS (3-2).

Introduction to the physics, engineering, and applications of optical fibers, electro-optic sources, sensors, and communication systems. The course will cover communication system design including component specification, data rates, power budgets, and optical amplifiers. The course will also cover sensor design including interferometric and intensity based sensors, fiber optic hydrophones, gyroscopes, and displacement sensors. PREREQUISITE: PH3360 or equivalent.

PH3451 FUNDAMENTAL ACOUSTICS. (4-2).

Development of, and solutions to, the acoustic wave equation in fluids. Propagation of plane, spherical and cylindrical waves in fluids. Sound pressure level, intensity, and specific acoustic impedance. Normal and oblique incidence reflection and transmission from plane boundaries. Transmission through a layer. Image theory and surface interference. Sound absorption and dispersion for classical and relaxing fluids. Acoustic behavior of sources and arrays, acoustical reciprocity, continuous line source, plane circular piston, radiation impedance, and the steered line array. Transducer properties, sensitivities, and calibration. Laboratory experiments include longitudinal waves in an air-filled tube, surface interference, properties of underwater transducers, three-element array, speed of sound in water, and absorption in gases. PREREQUISITES: PH 2119, PH 2724.

PH3452 UNDERWATER ACOUSTICS. (4-2).

This course is a continuation of PH 3451. Lumped acoustic elements and the resonant bubble. Introduction to simple transducers. Normal modes in rectangular and cylindrical enclosures. Steady-state response of acoustic waveguides of constant cross section, propagating evanescent modes, and group and phase speeds. Transmission of sound in the ocean, the Eikonal Equation and necessary space conditions for ray theory, and refraction and ray diagrams. Sound propagation in the mixed layer, the convergence zone, and the deep sound channel. Passive sonar equation, ambient noise and doppler effect and bandwidth considerations. Active sonar equations, target strength and reverberation. Laboratory experiments include Helmholtz resonators, normal modes in rectangular, cylindrical, and spherical enclosures, water-filled waveguide, noise analysis, impedance of a loudspeaker. PREREQUISITE: PH3451.

PH3458 NOISE, SHOCK AND VIBRATION CONTROL. (4-0).

The application of the principles of acoustics and mechanics to the problems of controlling noise, vibration and mechanical shock. Topics include linear mechanical vibrations; introduction to vibrations of nonlinear systems; damping mechanisms;

ibration and shock isolation; noise generation and control; effects of noise on man; application to problems of Naval interest such as ship quieting and industrial noise control. **PREREQUISITE:** A course in acoustics.

PH3479 PHYSICS OF UNDERWATER WEAPONS. (4-0).

The basic physics of underwater weapons from launch through explosion are addressed using a modern acoustic torpedo to illustrate practical applications. Topics include initial inputs, water entry, power plants, propulsors, drag and drag reduction, stability and control, guidance, acoustic search, terminal homing, exploders, and explosions.

PREREQUISITES: A course in acoustics and a SECRET NOFORN clearance.

PH3513 INTERMEDIATE ORBITAL MECHANICS. (V-0).

Orbital perturbations due to various sources, such as atmospheric drag and lunar tidal effects. Interplanetary trajectories. Additional topics depending on hours assigned to course. **PREREQUISITE:** PH 2511.

PH3516 ENVIRONMENTAL FACTORS IN SPACECRAFT DESIGN & OPERATIONS (3-0).

The environmental effects covered in this course include spacecraft charging, space radiation effects, natural and artificial space debris, and atmospheric effects. The nature of the physical interactions is emphasized.

PREREQUISITE: PH 2514.

PH3652 FOUNDATIONS OF QUANTUM DEVICES (4-1).

Continues the development of quantum physics for subsequent (i.e. later courses) application to real radiating systems (e.g. lasers) and detectors (e.g. photon and magnetic anomaly). Topics include statistical physics, perturbation theory, angular momentum, hydrogen atom, helium and multi-electron atoms, molecular states and spectra. **PREREQUISITES:** PH3991 and PH3292.

PH3653 QUANTUM DEVICES (4-0).

An application of quantum mechanical principles (including quantum statistics, barrier penetration, periodic potential) to detectors and radiating systems. Applications include lasers, photon detectors, magnetic anomaly detectors, image intensifiers. **PREREQUISITE:** PH3652

PH3782 THERMODYNAMICS AND STATISTICAL PHYSICS. (4-0).

Entropy, temperature, Boltzmann factor and Gibbs factor are developed from a quantum point of view. Blackbody radiation, chemical potential, partition function, Gibbs sum and applications to an ideal gas are covered. Fermi-Dirac and Bose-Einstein statistics and applications to degenerate systems. Gibbs free energy, Helmholtz free energy, enthalpy, kinetic theory, phase transformations, chemical reactions. **PREREQUISITE:** PH 2681.

PH3800 SURVEY of THE PHYSICS OF UNCONVENTIONAL WEAPONS (4-0).

A survey course to familiarize students in the Combat Systems Science & Technology curriculum with the physics issues of unconventional weapons and their effects. Blast effects appropriate to both conventional and nuclear weapons will be discussed and the physical origins of scaling laws will be presented. The physical basis of thermal radiation and electromagnetic pulse effects of nuclear weapons will be introduced with distinctions appropriate to strategic and smaller yield devices. The technical issues relating to weapons proliferation, safety and disposal will be discussed. An introduction to the physical bases of chemical, biological, nuclear and directed energy weapons and their delivery systems will be discussed. The course is intended to familiarize CSST students with the vocabulary of unconventional weapons and to show how the basic physics learned in previous courses within this curriculum can be applied to an unfamiliar technology. **PREREQUISITE:** PH3652.

PH3855 NUCLEAR PHYSICS. (4-2).

This is the first in a sequence of graduate specialization courses on nuclear weapons and their effects. This course deals with the necessary underlying principles of nuclear physics, including nuclear forces, models, stability, reactions and decay processes, and interaction of high energy particles with matter. The laboratory includes radiation detection techniques and statistics of counting. PREREQUISITES: PH 3152, PH 3360, and PH 3653 or equivalents. The course PH3653 may be taken concurrently.

PH3921 NONLINEAR DYNAMICS, CHAOS, FRACTALS AND ALL THAT. (V-0).

The existence of chaotic dynamics has been discussed in the literature for many decades and is associated with names like Poincare, Birkhoff, Kolmogorov and others. However, it is only recently that the wide ranging impact of chaos has been recognized. The field is undergoing explosive growth and many applications have been made across a broad spectrum of scientific disciplines - ecology, economics, physics, chemistry, engineering, and fluid mechanics. Much effort is driven by the hope that it may be possible to find unifying principles that characterize and classify large classes of nonlinear complex systems. This course is an introduction into the concepts and the language used in this rapidly growing exciting field from a physicist's point of view. PREREQUISITE: PH 2151 or equivalent.

PH3991 PHYSICS OF OSCILLATIONS AND WAVES II. (4-0).

Fourier integrals and the application of contour integrals to evaluate them. Special relativity. Physical derivation of partial differential equations describing heat flow, electromagnetic waves, elastic waves, followed by separation of variables in Cartesian and curvilinear coordinates. Frobenius method applied to the resulting ordinary differential equations, yielding special functions (Legendre, Bessel, Hermite, Laguerre). Sturm-Liouville equation and orthogonal functions. Particle nature of light and wave nature of matter. Black-body radiation, Bohr atom, Schroedinger's equation applied to square well, harmonic oscillator, and hydrogen atom. PREREQUISITE: PH2990.

PH3998 SPECIAL TOPICS IN INTERMEDIATE PHYSICS. (V-0).

Study in one of the fields of intermediate physics and related applied areas selected to meet special needs or interests of students. The course may be conducted as a seminar or supervised reading in different topics. PREREQUISITES: A 2000 level course appropriate to the subject to be studied, and consent of the Department Chairman. The course may also be taken on a Pass/Fail basis provided the student has requested so at the time of enrollment.

PH4002 UNDERSEAS WARFARE SENSORS II (4-0). Description to follow.

PH4050 SENSORS AND DEVICES (4-2).

Fundamentals of critical sensor systems and devices for target detection tracking and surveillance. Review of wave propagation, interference and diffraction. Pulsed, phased array and synthetic aperture radars systems Opti-electronic detectors; CCD imagers, infrared scanning devices, and plane arrays. Active and passive acoustic systems, sonar arrays, and focal plane arrays. Chemical and biological sensors. Seismic and radiation sensors for the detection of nuclear weapons. Course includes demonstration and onsite facility visits. PREREQUISITES: PH3991, SE2013, PH3653 and a course in electromagnetism.

PH4051 ADVANCED CONCEPTS IN SURVEILLANCE, TARGET ACQUISITION AND ENGAGEMENT. (4-0).

Techniques and procedures needed to cope with severe atmospheric and ocean environmental constraints imposed on military surveillance, target acquisition and weapon systems. Attenuation, scattering and multipath effects coupled with stratification and random density degrade radar, optical, infrared and acoustic systems

Topics include: propagation, conventional and nonconventional adaptive optics, phase conjugation, cluttered background phenomena, caustics, speckle as well as advanced ASW and mine-detection techniques such as ELFE, low frequency E & M, electro-galvanic, and turbulent wakes. PREREQUISITES: PH4050 or equivalent.

PH4054 PHYSICS OF DIRECTED ENERGY WEAPONS. (4-0).

This course is an in-depth study into the beam weapon concepts. Topics covered are: relativistic electron beams; their equilibrium, propagation losses and stability; giant power accelerator concepts; target interaction; proton beams; neutral particle beams, their production and limitations; high power microwave beams, high energy laser beams, their production, atmospheric propagation and control and their interaction with targets. PREREQUISITES: PH 3352, PH 2151 or equivalent courses in electromagnetism and mechanics. SECRET clearance.

PH4162 MECHANICS OF CONTINUA. (3-0).

The foundations of fluid mechanics presented in the tensor formulation. Scalars, vectors, and tensors. Tensor differential and integral calculus. The stress tensor and rate of deformation tensor. Principal values, deviators, and their invariants. Fundamental laws: conservation of mass, linear momentum, angular momentum, and energy. Constitutive equations. Non-Newtonian fluids. Visco-Plastic materials. PREREQUISITES: PH 3161 or equivalent.

PH4209 EO/IR SYSTEMS AND COUNTERMEASURES. (3-2).

This unclassified course for students in interdisciplinary curricula treats the military applications of electro-optic systems, including IR and EO seekers and trackers, surveillance and missile warning systems, and laser rangefinders and designators. Scanning FLIR and IRST systems and array applications will be included. Signature suppression and generic active and passive countermeasure approaches will be discussed. Laboratory work will deal with EO/IR devices and possible countermeasure techniques. PREREQUISITES: PH 3208, MA 3139.

PH4253 SENSORS, SIGNALS, AND SYSTEMS. (4-2).

This course treats the physical phenomena and practical problems involved in sensor systems for electromagnetic signals in the EO/IR range. Topics included are: optical modulation, nonlinear optics, acousto-optics; atmospheric molecular absorption characteristics and mechanisms of detectors for optical and infrared radiation, noise in detectors, cooling systems; image intensifiers, television and FLIR systems; detecting, tracking and homing systems; signal sources, target signatures and backgrounds; laser target designators, laser radars, the range equation. The laboratory will include experiments related to this material as well as to that of the preceding course, PH 3252. PREREQUISITES: PH 3252 and a course in electromagnetism.

PH4254 THERMAL IMAGING AND SURVEILLANCE SYSTEMS. (4-0).

This course is intended as a capstone course to follow the sequence PH 3252 and PH 4253, or the sequence PH 2207 and PH 3208. It will address the system analysis and technology of infrared imaging and search/track systems, including the derivation of system performance measures such as Minimum Detectable Temperature Difference, (MDT), and Minimum Resolvable Temperature Difference (MRTD) in terms of the optics, scanner, detectors, display, and human operator characteristics. Performance Prediction codes and Tactical Decision Aids (TDAs) will be analyzed for current Forward Looking Infra Red (FLIR) Systems, and comparable codes for IRSTs discussed. Criteria for target detection and transference of contrast will be compared. Integrated Focal Plane Array Technology will be explored for application to second generation FLIR and Staring Imager development. PREREQUISITES: PH 3208 or PH 4253 or consent of instructor.

PH4283 LASER PHYSICS. (4-0).

The physics of lasers and laser radiation. Topics will include: spontaneous and stimulated emission, absorption, interaction of radiation with matter, line broadening mechanisms, optical and electrical pumping, gain, properties of laser beams. Gaussian beams, stable and unstable resonators, rate equations, output coupling, mode locking, short pulsing, specifics of solid state and gas laser systems, high energy and high power lasers, laser-surface interaction, air breakdown, laser supported detonation waves, laser isotope separation, and laser fusion. PREREQUISITE: PH 3252 or equivalent, or consent of instructor.

PH4353 TOPICS IN ADVANCED ELECTRICITY AND MAGNETISM. (4-0).

Topics selected from: Electromagnetic radiation, including radiation from antennas and accelerating particles, and radiation scattering from charged particles. Additional topics may include Cerenkov radiation, free electron lasers, and the relativistic formulation of electrodynamics. PREREQUISITES: PH3152, PH3352 and PH3991.

PH4354 ADVANCED ELECTROMAGNETIC RADIATION (4-0).

Electromagnetic radiation from accelerating particles and antennas, including Yagi antennas and phased arrays. Radar sources such as klystrons. Radiation scattering, including Rayleigh scattering, Mie scattering and scattering from rough surfaces. Relativistic electrodynamics. PREREQUISITES: PH3352, and PH3991.

PH4371 CLASSICAL ELECTRODYNAMICS. (3-0).

Tensors in special relativity. Classical relativistic electromagnetic field theory. Lorentz electron theory. PREREQUISITES: PH 4353 and familiarity with the special theory of relativity and Lagrangian mechanics.

PH4410 ADVANCED ACOUSTICS LABORATORY. (1-6).

Advanced laboratory projects in acoustics. Through the performance of experiments drawn from diverse fields of acoustics, the student is introduced to the problems and opportunities of acoustics research. For each experiment the student is guided through the scientific literature on the subject, the construction of the equipment, the collection and analysis of the data, and the writing of a research report. PREREQUISITE: PH 3452.

PH4453 SCATTERING AND FLUCTUATION OF SOUND IN THE OCEAN (4-0).

An advanced treatment of the effects of variations of the ocean and its boundaries on ocean noise and the scattering and fluctuation of sound. Topics include: multipole radiation fields and noise sources in the sea, coherence and incoherence, probability density functions, the Hemholtz integral and general scattering formalism, scattering from objects, correlations and frequency spectra of sound scattered from rough boundaries, fluctuations associated with variability in the medium. PREREQUISITE: PH 3452 or consent of the instructor.

PH4454 SONAR TRANSDUCER THEORY AND DESIGN. (4-2).

A treatment of the fundamental phenomena basic to the design of sonar transducers, specific examples of their application and design exercises. Topics include piezoelectric, magnetostrictive and hydromechanical effects. Laboratory includes experiments on measurement techniques, properties of transducer materials, characteristics of typical navy transducers, and a design project. A field trip to visit one or more transducer manufacturers is normally scheduled during the course. PREREQUISITE: PH3452 (may be taken concurrently).

PH4455 SOUND PROPAGATION IN THE OCEAN. (4-0).

An advanced treatment of the subject. Topics include; Reflection of spherical waves from ocean boundaries. Normal mode propagation of sound. Inhomogeneous wave equation and the point source in cylindrical coordinates.

shallow water channel with fluid and solid bottoms. The deep sound channel and the WKB approximation. Range-dependent channels. Adiabatic normal modes and the parabolic equation. Multi-path propagation. Application to Arctic ocean acoustics. PREREQUISITE: PH3452 or consent of instructor.

PH4456 SEMINAR IN APPLICATION OF UNDERWATER SOUND. (3-0).

A study of current literature on application of acoustics to problems of Naval interest. PREREQUISITE: PH3402 or PH3452 or PH4403 or consent of the instructor.

PH4459 SHOCK WAVES AND HIGH-INTENSITY SOUND. (3-0).

Nonlinear oscillations and waves on strings. The nonlinear acoustic wave equation and its solution. The parametric array. The physics of shock waves in air and in water. PREREQUISITE: PH 3451.

PH4515 PHYSICS OF THE SATELLITE ENVIRONMENT. (3-0).

A graduate level treatment of the structure and properties of the near earth space environment and some aspects of solar physics. Topics (usually two per quarter) are chosen from: ionospheric composition, ionospheric radio wave propagation, structure of the magnetosphere, the geomagnetic field, solar structure and emissions. PREREQUISITES: PH2514 and a 3000 level course in electromagnetism. Some background in plasma physics is desirable.

PH4531 INTRODUCTION TO ASTROPHYSICS. (4-0).

Introduction to theories of stellar structure, energy transport in stars, and stellar evolution. Recent advances in solar physics. Supernovae, pulsars, black holes, and the origin of the universe will be topics of discussion. PREREQUISITES: PH 3152 and PH 3352.

PH4661 PLASMA PHYSICS I. (4-0).

This course constitutes a broad study of the behavior and properties of gaseous plasma, the fourth - and most abundant - state of matter in the universe. Plasma physics is a vigorously developing branch of contemporary physics. Its many applications are in areas such as astro and space-physics, atomic physics, magneto-hydrodynamic power generation, electron beam excited laser, laser isotope enrichment, ionospheric communication, thermonuclear fusion, and high energy beam weapons. The physical concepts fundamental to various branches of plasma physics are introduced. Topics covered include single particle motions in electromagnetic fields, orbit theory, collision phenomena, breakdown in gases, and diffusion. The magneto-hydrodynamic and the two-fluid plasma models are considered. PREREQUISITE: PH 3360, or the equivalent.

PH4662 PLASMA PHYSICS II. (3-0).

A continuation of Plasma Physics I. Applications of the hydromagnetic equations to the study of macroscopic motions of plasma. Equilibrium and stability. Classification of plasma instabilities. Kinetic theory, the Boltzmann equation and the macroscopic-momentum transport equation. Plasma oscillations and Landau damping. Nonlinear effects, shock waves, radiations from plasma, including bremsstrahlung and cyclotron radiation. Controlled fusion and laser produced plasmas. PREREQUISITES: PH 4661 or consent of instructor.

PH4750 SOLIDS AND RADIATION EFFECTS. (4-0).

An introduction to solid state physics and radiation effects. Free electron theory, bands, semiconductors, and lattice structure are discussed. Radiation damage mechanisms, TREE, and hardening concepts are introduced. PREREQUISITES: PH3352 and PH3653.

PH4760 SOLID STATE PHYSICS. (4-0).

Fundamental theory dealing with solids: crystals, binding energy, lattice

vibration, dislocations and mechanical properties, free electron theory, band theory, properties of semi-conductors and insulators, magnetism. PREREQUISITES: PH 3653 and PH 3782 (the latter may be taken concurrently).

PH4771 STATISTICAL PHYSICS. (3-0).

Kinetic theory and the Boltzmann theorem, configuration and phase space, the Liouville theorem, ensemble theory, microcanonical, canonical and grand canonical ensembles, quantum statistics. Applications to molecules, Bose-Einstein gases, Fermi-Dirac liquids and irreversible processes. PREREQUISITES: PH3152, PH3653 and PH3782.

PH4856 PHYSICS OF NUCLEAR WEAPONS. (4-0).

This second course in the nuclear weapons effects graduate specialization sequence considers in-depth questions of weapon designs and their specific output environments which are created by the nuclear explosion. Topics are: principles affecting weapon yield efficiency; explosion phenomenology in various ambient environments, blast and shock, thermal radiation, X-rays and gamma rays, neutron fluxes, electromagnetic pulse, radioactive fallout models. PREREQUISITE: PH 3855 and SECRET clearance.

PH4857 PHYSICS OF HIGH VELOCITY IMPACT PHENOMENA IN SOLIDS(4-0)

This course is designed for students of the Combat System Science and Technology Curriculum taking the Weapon Effects concentration. It gives a broad overview of the impact response of materials from the linear elastic through the nonlinear plastic and hydrodynamic deformation regimes. Emphasis is on thorough coverage of fundamentals and their application to the dynamic behavior of materials subject to intense short duration loading. Topics are stress waves in solids, limitations of elementary wave theory, elastic plastic stress waves, penetration and perforation, hypervelocity impact, material behavior at high strain rates, dynamic fracture, simulation computer models of high velocity impact. PREREQUISITES: PH3171, PH3172.

PH4858 WEAPONS LETHALITY & SURVIVABILITY (3-0).

This course will cover the principles and effectiveness of advanced conventional warheads and new armor concepts for a range of military applications. Topics will include kinetic energy penetration, shaped charges, fragmentation warheads, and selected directed energy weapons applications. Advanced armor concepts will include the use of ceramics and their behavior under high velocity impact and penetration and possible armor applications to ship protection. PREREQUISITES: PH4857 and SECRET clearance.

PH4911 SIMULATION OF PHYSICAL AND WEAPON SYSTEMS (3-2).

The role of computation physics in modern weapons development and combat simulations. The programming language is C within the UNIX operating systems. Applications emphasize physical principles of weapons development, and the use of graphics. Subject matter includes random number distributions, projectile and fragment dispersion, free electron laser simulation, molecular dynamics in solids, liquids and gases, wave propagation in various media, and numerical integration methods. PREREQUISITES: PH2170, PH2911, PH3352.

PH4971 QUANTUM MECHANICS I. (3-0).

Review of Lagrange's and Hamilton's equations of motion. Poisson brackets. General principles of non-relativistic quantum mechanics; stationary states. PREREQUISITES: PH 2681, PH 3152.

PH4972 QUANTUM MECHANICS II. (3-0).

Addition of angular momenta; scattering theory; additional topics of interest to students and instructor. PREREQUISITE: PH 4971.

PH4973 QUANTUM MECHANICS III. (3-0).

General principles of relativistic quantum mechanics. Properties and solutions of relativistic wave equations. PREREQUISITES: PH 4371 and PH 4971.

PH4984 ADVANCED QUANTUM PHYSICS. (4-0).

Quantum mechanics in the Dirac format. Angular momentum, spin, spin resonance. Additional topics may include group theoretical applications to selection rules and crystal fields, variational principles, self-consistent fields in the many-electron atom, scattering theory, and polyatomic molecules. PREREQUISITES: PH3152 and PH3653.

PH4991 RELATIVITY AND COSMOLOGY. (3-0).

Einstein's general theory of relativity. The three classical tests. The Schwarzschild singularity and black holes. Cosmological models and their relations with observations. Introduction to modern developments; gravitational waves, problems of quantum cosmology and superspace. PREREQUISITE: PH 4371.

PH4998 SPECIAL TOPICS IN ADVANCED PHYSICS. (V-0).

Study in one of the fields of advanced physics and related applied areas selected to meet special needs or interests of students. The course may be conducted as a seminar or supervised reading. The course carries a letter grade and may be repeated in different topics. PREREQUISITES: A 3000 level course appropriate to the subject to be studied, and consent of the Department Chairman. It may also be taken on a Pass/Fail basis if the student has requested so at the time of enrollment.

SE2012 APPLIED PHYSICS LABORATORY I: FUNDAMENTALS (2-3).

An introduction to the analysis of experimental data and signals in the applied physics laboratory. Experimental uncertainties and error propagation in physical measurements. Statistical mean and standard deviation. Gauss, Poisson and binomial probability distributions. Least-squares techniques. Introduction to simple circuits. Ohm's and Kirchhoff's laws. Complex number and phasor representations of physical quantities. Introduction to applied Fourier analysis. Laboratory exercises based upon applications in mechanics, optics and signal processing. PREREQUISITE: Previous college courses in basic physics and mathematics.

SE2013 APPLIED PHYSICS LABORATORY II: ANALOG TECHNIQUES (2-3).

A continuation of the signal analysis and electronic circuit topic begun in SE2012, with an emphasis on analog signal processing. Op-amps and negative feedback, continued. Semiconductor basics. PN junction diodes, bipolar transistors and field effect transistors. Resonance. The Fourier transform as an extension of Fourier series to non-periodic signals. Active filter circuits. Transfer function and the Fourier analysis of filters. Oscillators. Amplitude, frequency and phase modulation techniques, and their applications to communications. Phase-sensitive detection and the lock-in amplifier. Principles of fiber optics communications. Laboratory exercises drawn from applications in electronic signal analysis, acoustics and optoelectronics. PREREQUISITES: SE2012 or equivalent.

SE2014 APPLIED PHYSICS LABORATORY III: DIGITAL TECHNIQUES (2-3).

A continuation of signal analysis and electronics topics, with their applications to hands-on physical measurements and applied physics problems. Topics include: combinational logic, Boolean algebra, TTL and CMOS logic families, basic gates, flip-flops, latches, counters, shift registers and arithmetic circuits. Device-interfacing fundamentals are also covered, including binary and ASCII codes, digital-to-analog and analog-to-digital converters, and related topics. The course culminates in the development of a student project to perform a set of precise physical measurements, such as the speed of light and the speed of sound. PREREQUISITE: SE2013 or equivalent.

SE2020 COMBAT SYSTEMS REQUIREMENTS AND DESIGN (1-0).

This course develops the requirements for and investigates the conceptual system design for combat systems of contemporary interest. The operational problem selected for detailed definition and solution are at the limits of today's technology and operational arts. Examples include defense against tactical ballistic missiles, zero-collateral-damage counter-battery combat systems, and shallow water antisubmarine and mine warfare robot based systems. The system project is introduced in the first quarter of the officer's curriculum. Subsequent quarters involve seminars, guest lectures, and discrete problems and subprojects integrated into the courses of the curriculum. The project is brought to completion in a systems integration course (SE4021) taught in the third quarter before graduation. **PREREQUISITE:** Enrollment in the Combat Systems Science & Technology Curriculum or consent of the instructor.

SE3015 APPLIED PHYSICS LABORATORY IV: SYSTEMS CONTROL (2-3).

This course applies the concepts of the applied Physics I-III sequence to digital data acquisition and control systems. The course covers microprocessor architectures and digital communications using serial, RS-232, parallel, IEEE-488 interfaces, as well as digital and analog interfacing. Two key areas involve the use of small computers for the control of, and data acquisition from peripheral devices. The use of electro-mechanical servo systems for closed-loop feedback control of mechanical devices, such as positioning, pointing and tracking systems. **PREREQUISITES:** SE2014 and PH2911 or equivalent.

SE3301 RADIATING SYSTEMS. (4-0).

This course for students of Operations Research and other Weapon System oriented non-engineering curricula discusses the physical principles exploited by information gathering systems with emphasis on general capabilities and limitations. After a general introduction to wave propagation, topics of discussion are electromagnetic waves, radar, electro-optics including lasers and underwater sound. These topics will be applied to specific systems such as missile guidance, sonobuoys, and phased arrays as appropriate to the class and instructor. **PREREQUISITES:** MA1116 or equivalent may be taken concurrently, or by consent of instructor.

SE4006 TECHNICAL ASSESSMENT OF WEAPON SYSTEMS. (4-0).

This course is designed to support the Intelligence Curriculum. Current technical trends in weapon system technologies which are expected to significantly affect warfare are investigated. Topics covered are: nuclear weapons and their effects, nuclear strategic balance, satellite orbits, directed energy weapon concepts (SDI), future weapon concepts. **PREREQUISITES:** SE3301 or equivalent, and SECRET clearance.

SE4021 COMBAT SYSTEM PROJECT INTEGRATION. (4-0).

This course, a continuation of SE2020, integrates the results of the subsystem studies begun in SE2020 into the design of a combat system that solves an operational problem. (See SE2020 for the types of problems studied). The resulting solution will address the threat and operational environment; the assignment of tasks to system components; the performance of the system in terms of its coverage, fire power, reaction time, and response to counter measures; and costs. The results are presented to an experienced external review group. **PREREQUISITE:** SE2020 or consent of the instructor. SECRET clearance required.

PH4858 NUCLEAR WARFARE ANALYSIS. (4-0).

This final course in the nuclear weapons effects graduate specialization sequence deals with technical aspects of strategic and tactical nuclear war. Effects which nuclear weapons explosion environments have on various defense platforms and systems are considered together with methods of hardening to reduce system vulnerability in each of the effected areas: blast and shock, thermal radiation, transient effects on electronics. EMP, biological effects from contamination, atmospheric and ionospheric effects on communication, detection and surveillance systems PREREQUITES: PH3171, PH4856, and SECRET clearance.

PH4859 TECHNICAL ASPECTS OF WEAPON PROLIFERATION, CONTROL & DISPOSAL (3-0).

This course is designed for students of the Combat Science and Technology Curriculum making the Weapon Effects concentration. The course address technical issues of detection of nuclear weapon materials, covert explosions, disposition of weapon grade material and nuclear reactor fuel, control and disposition of chemical and biological weapons, policy issues of arms proliferation and arms control. PREREQUISITE: Consent of instructor.

SPACE SYSTEMS ACADEMIC GROUP

Chairman:

Rudolf Panholzer
Professor
Code SP, Bullard Hall
Room 205
(408) 656-2278
DSN 878-2278

The Space Systems Academic Group is an interdisciplinary association of faculty, representing eight separate academic disciplines. The Space Systems Academic Group has responsibility for the academic content of the Space Systems Operations and the Space Systems Engineering curricula. Instruction is carried out by faculty members attached to the following academic departments: Administrative Sciences, Aeronautics and Astronautics, Electrical and Computer Engineering, Mathematics, Meteorology, Oceanography, Operations Research and Physics. Thesis topics for students in this area of study are approved by the group and the final thesis is approved by the group Chairman in addition to the academic department granting the degree (if any).

GROUP FACILITIES

To provide laboratory experience several facilities have been developed in cooperation with other academic departments.

- 1) Solar Simulation Facility
- 2) Flash X-Ray Facility
- 3) Electron Linear Accelerator
- 4) Navigational Satellite Receiver Laboratory
- 5) Small Satellite Test and Development Laboratory
- 6) Vibro-Acoustic Test and Measurement Facility
- 7) FLTSATCOM Laboratory
- 8) Access to the Special Compartmented Information Facility for Classified Research and Theses Work.
- 9) Spacecraft Testing Laboratory
- 10) Spacecraft Attitude Dynamics and Control Laboratory

DEGREE REQUIREMENTS

The Space Systems Engineering students earn a master's degree in one of the following academic departments: Aeronautics and Astronautics, Computer Science, Electrical and Computer Engineering, Mechanical Engineering, Physics or Mathematics. Refer to degree requirements for the listed departments.

The Space Systems Operations students are awarded the degree Master of Science in Systems Technology (Space Systems Operations). A minimum of 45 quarter hours of graduate level work of which at least 15 hours must represent courses at the 4000 level. Graduate courses in at least four different academic disciplines must be included and in two disciplines, a course at the 4000 level must be included. There is also a requirement of three courses constituting advanced study in an area of specialization. Each student is required to write a thesis which is space oriented. The study program must be approved by the Chairman of the Space Systems Academic Group.

COURSE OFFERINGS

SS0810 THESIS RESEARCH (0-8).

Every student conducting thesis research enrolls in this course.

SS2001 INTRODUCTION TO SPACE. (4-0).

An overview of space science, technology and policy with emphasis on topics of military interest. Topics usually included are: Space Environment, Orbital Mechanics, Directed Energy Techniques, Space Power Systems, Guidance and Control, Communications, Propulsion and Launch Vehicles. Space Policy and organization.

SS3001 MILITARY APPLICATIONS OF SPACE (3-2).

Examination of the military functions which utilize space systems and the capabilities of current and future space systems with tactical or strategic applications. Tasking and use of space systems and ground support elements. Vulnerability considerations. Impact of current R&D programs. PREREQUISITES: Orbital mechanics, Fourier analysis, and TOP SECRET clearance with eligibility for SI/SAO. U.S. citizenship.

SS3035 MICROPROCESSORS FOR SPACE APPLICATIONS (3-2).

An introduction to microprocessors at the hardware/software interface. Machine language programming, assembly language programming, connecting and controlling peripherals (terminals, disc drives, etc.), operating systems. PREREQUISITE: EC2820.

SS3525 AIR/OCEAN REMOTE SENSING FOR INTERDISCIPLINARY CURRICULA. (3-2).

Principles of radiative transfer and satellite sensors, and methods used to measure the atmosphere and ocean; visual, infrared and microwave radiometry, and radar systems. Laboratory sessions illustrate lecture concepts using interactive displays of satellite data. Course designed for Space Operations, Space Systems Engineering, Anti-Submarine Warfare, Underwater Acoustics and other interdisciplinary curricula. PREREQUISITES: Undergraduate physics, and differential/integral calculus and ordinary differential equations; or consent of instructor.

SS3900 SPECIAL TOPICS IN SPACE SYSTEMS. (V-0).

Directed study either experimental or theoretical in nature. PREREQUISITE: Consent of Chairman of Space Systems Academic Group and instructor. May be taken on Pass/Fail basis if the student has requested so at the time of enrollment.

SS4000 SPACE SYSTEMS SEMINARS AND FIELD TRIPS. (0-1).

Seminars consist of lectures to provide perspective on Space Systems. Field trips expose the student to various space activities such as industry, NASA and DoD laboratories and commands.

SS4001 DECISIONS AND SPACE SYSTEMS. (4-2).

Cost-Performance Analysis including mission analysis, measures of performance and cost models. Study of the revolution of the interaction of technology, economics and politics in determining space-related activities. Discussion of the militarization of space. PREREQUISITES: OS 3008, MN 3301, TOP SECRET clearance with eligibility for SI/SAO. U.S. citizenship.

SS4002 MILITARY OPERATIONS IN SPACE (4-0).

Operation of space systems to achieve mission objectives. Periods of vulnerability. Launch windows. Satellite defense: hardening, maneuver, encryption, covert spores, etc. ASAT operations, Launch windows. Weapons in space and threats to space systems. PREREQUISITE: SS 4001, OS 3603, TOP SECRET clearance with eligibility for SI/SAO. U.S. citizenship.

SS4003 SPACECRAFT DESIGN STUDIES (0-1)

Students registered for SS4003 are typically those whose thesis is on some element of the PANSAT project. In SS4003 the systems-level aspect of the design is discussed. The format is a combination of oral presentation and discussion. The purpose of this class is to give students an appreciation of the "big picture" and to demonstrate how individual research efforts fit into the "grand scheme of things. The concurrent engineering design approach makes this class a simulation of Design Meetings held in a typical Industrial Environment. Faculty, SSAG engineering staff and students participate in the weekly meetings. PREREQUISITE: None.

SS4900 ADVANCED STUDY IN SPACE SYSTEMS. (V-0).

Directed graduate study based on journal literature, experimental projects, or other sources. PREREQUISITE: Consent of Chairman of Space Systems Academic Group and Instructor. May be taken on Pass/Fail basis if the student has requested so at the time of enrollment.

DEPARTMENT OF SYSTEMS MANAGEMENT

Chairman:

David R. Whipple, Jr.,
Professor
Code SM/Wp, Ingersoll Hall
Room 229
(408)656-2161
DSN 878-2161

Tarek Abdel-Hamid, Associate Chair for Research, Associate Professor of Management Information Systems (1986)*; PhD, MIT Sloan School of Management, 1984.

Rebecca J. Adams, CDR, U.S. Navy, Lecturer in Acquisition & Contracting (1992); MS, Naval Postgraduate School, 1987.

Associate Chairmen:

Instruction
Reuben T. Harris
Professor
Code SM/Hr, Ingersoll Hall
Room 331-B
(408)656-2768
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Frank J. Barrett, Assistant Professor of Organization and Management (1990); PhD, Case Western Reserve University, 1989.

Robert Barrios-Choplin, Visiting Assistant Professor of Management (1991); PhD, University of Texas, 1993.

Hemant K. Bhargava, Assistant Professor of Management Information Systems (1989); PhD, The Wharton School, University of Pennsylvania, 1990.

Dan C. Boger, Professor of Economics (1979); PhD, University of California at Berkeley, 1979.

David G. Brown, Visiting Assistant Professor of Transportation and Logistics (1991); PhD, University of Illinois at Urbana-Champaign, 1988.

Rex A. Buddenberg, Lecturer in Information Systems (1993); MS, Naval Postgraduate School, 1986.

Tung X. Bui, Associate Professor of Management Information Systems (1984); PhD, New York University, 1985.

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Systems Development
Shu S. Liao
Professor
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Room 321
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Paul M. Carrick, Associate Professor of Economics, Emeritus (1969); PhD, University of California at Berkeley, 1956.

Alice Crawford, Visiting Assistant Professor of Psychology (1988); MA, San Diego State University, 1973.

Sandra M. Desbrow, Assistant Professor in Contract Management (1994); LL.M., Georgetown University Law Center, 1990.

John T. Dillard, LTC, U.S. Army, Lecturer in Acquisition Management (1994); MS, University of Southern California, 1985.

Daniel R. Dolk, Professor of Management Information Systems (1982); PhD, University of Arizona, 1982.

Julie A Dougherty, LT, U.S. Navy, Lecturer in Manpower, Personnel and Training Analysis (1994); MS, Naval Postgraduate School, 1991.

Richard B. Doyle, Associate Professor of Public Budgeting (1990); PhD, University of Washington, 1982.

- Donald R. Eaton**, RADM (ret.), Logistics Chair, Professor in Logistics (1994); MS, George Washington University, Industrial College of the Armed Forces, 1980.
- Jeremy, E. Edwards**, Visiting Assistant Professor of Organization and Management (1993); EdD, University of San Francisco, 1989.
- Mark Jan Eitelberg**, Associate Professor of Public Administration (1982); PhD, New York University, 1979.
- Richard S. Elster**, Dean of Instruction, Professor of Systems Management (1969); PhD, University of Minnesota, 1967.
- James C. Emery**, Professor of Management Information Systems (1993); PhD, MIT Sloan School of Management, 1965.
- Kenneth J. Euske**, Professor of Accounting (1978); PhD, Arizona State University, 1978.
- Roger D. Evered**, Professor of Management (1979); PhD, University of California at Los Angeles, 1973.
- Paul J. Fields**, Assistant Professor of Operations Management and Logistics (1993); PhD, Pennsylvania State University, 1992.
- James M. Fremgen**, Professor of Accounting (1965); DBA, Indiana University, 1961.
- Garry A. Frew**, Associate Professor of Information Systems (1984); MS, Naval Postgraduate School, 1984.
- William R. Gates**, Visiting Assistant Professor of Economics (1988); PhD, Yale University, 1984.
- William J. Haga**, Visiting Associate Professor of Management Information Systems (1988); PhD, University of Illinois, 1972.
- Leuben T. Harris**, Associate Chair for Instruction, Professor of Management (1978); PhD, Stanford University, 1975.
- David R. Henderson**, Associate Professor of Economics (1984); PhD, University of California at Los Angeles, 1976.
- Gregory G. Hildebrandt**, Visiting Associate Professor of Economics (1992); PhD, Princeton University, 1976.
- Susan P. Hocevar**, Visiting Assistant Professor of Organization and Management (1990); PhD, University of Southern California, 1990.
- Thomas H. Hoivik**, Senior Lecturer in Acquisition and Contract Management (1991); MA, Naval Postgraduate School, 1973; MS, Salve Regina University, 1988.
- Kenn C. Horton**, Senior Lecturer of Economics (1964); PhD, Claremont Graduate School, 1968.
- Rik Jansen**, Visiting Associate Professor of Organization and Management (1994); PhD, University of Southern California, 1987.
- Earl R. Jones**, Professor of Information and Telecommunications Systems (1965); PhD, Claremont Graduate School, 1965.
- Lawrence R. Jones**, Professor of Financial Management and Budgeting (1987); PhD, University of California at Berkeley, 1977.
- Louis Kalmar**, CDR, U.S. Navy, Lecturer in Financial Management (1992); MBA,

Rensselaer Polytechnic Institute, 1988.

Magdi N. Kamel, Associate Professor of Management Information Systems (1988); PhD University of Pennsylvania, The Wharton School, 1988.

Keebom Kang, Associate Professor of Logistics (1988); PhD, Industrial Engineering, Purdue University, 1984.

David V. Lamm, Associate Professor of Acquisition and Contract Management (1978); DBA, George Washington University, 1976.

Shu S. Liao, Associate Chair for Systems Development, Professor of Accounting (1977) PhD, University of Illinois, 1971.

Gordon E. Louvau, Lecturer in Accounting (1994); MBA, John F. Kennedy University, 1980.

David F. Mathews, Senior Lecturer in Acquisition Management (1994); MA, Middle Tennessee State University, 1974.

Jerry L. McCaffery, Professor of Public Budgeting (1984); PhD, University of Wisconsin, 1972.

Martin J. McCaffrey, Visiting Assistant Professor of Contracting and Acquisition and Management Information Systems (1988); MS, Naval Postgraduate School, 1985.

Alan W. McMasters, Professor of Operations Research and Systems Management (1965); PhD, University of California at Berkeley, 1966.

Stephen L. Mehay, Professor of Labor Economics (1985); PhD, University of California at Los Angeles, 1973.

Brooks P. Merritt, Research Assistant Professor/Deputy Director, CAETR (1994); MS, Naval Postgraduate School, 1987.

O. Douglas Moses, Associate Professor of Accounting (1985); PhD, University of California at Los Angeles, 1983.

Walter E. Owen, LCDR, U.S. Navy, Lecturer in Acquisition Management (1992); MS, Naval Postgraduate School, 1992.

Balasubramaniam Ramesh, Assistant Professor of Information Systems (1990); PhD, New York University, 1992.

Benjamin J. Roberts, Associate Professor of Management and Human Resource Development (1985); PhD, Pennsylvania State University, 1977.

Nancy C. Roberts, Associate Professor of Strategic Management (1986); PhD, Stanford University, 1983.

Joseph G. San Miguel, Professor of Accounting (1982); PhD, University of Texas, 1972.

Norman F. Schneidewind, Professor of Information Sciences (1971); DBA, University of Southern California, 1966.

Kishore Sengupta, Assistant Professor of Management Information Systems (1989); PhD, Case Western Reserve University, 1990.

Sterling D. Sessions, Senior Lecturer in Systems Management (1989); PhD, Harvard University, 1962.

William B. Short, CDR, U.S. Navy, Lecturer in Management Information Systems (1992); MS, Naval Postgraduate School, 1983.

Keith F. Snider, LTC, U.S. Army, Lecturer in Acquisition Management (1993); MS, Naval Postgraduate School, 1982.

Muresh Sridhar, Visiting Assistant Professor in Information Systems (1994); PhD, Vanderbilt University, 1994.

Mark W. Stone, Assistant Professor, Lecturer in Acquisition and Contracting (1993); D, Santa Clara University School of Law, 1988.

James E. Suchan, Associate Professor of Management Communications (1986); PhD, University of Illinois, 1980.

Lyung Suh, Assistant Professor of Management Information Systems (1989); PhD, University of Rochester, 1989.

Atsushi Terasawa, Visiting Associate Professor of Economics and Policy Analysis (1989); PhD, University of Kansas, 1971.

Neil Fann Thomas, Associate Professor of Management Communications (1989); EdD, Arizona State University, 1986.

George W. Thomas, Associate Professor of Economics (1978); PhD, Purdue University, 1971.

Kenneth W. Thomas, Professor of Systems Management (1987); PhD, Purdue University, 1971.

Inda E. Wargo, Lecturer in Total Quality Leadership (TQL) (1991); MS, Naval Postgraduate School, 1983.

Jeffery A. Warmington, CDR, U.S. Navy, Lecturer in Acquisition & Contracting (1992); S, Naval Postgraduate School, 1988.

Donald A. Weitzman, Associate Professor of Psychology (1971); PhD, Princeton University, 1959.

Avid R. Whipple, Jr., Chairman of Systems Management, Professor of Economics and Policy Analysis (1971); PhD, University of Kansas, 1971.

Leslie J. Zambo, Visiting Associate Professor of Financial Management (1986); PhD, University of Texas, 1981.

Joshua E. Zviran, Visiting Assistant Professor of Management Information Systems (1988); PhD, Tel Aviv University, 1988.

The year of joining the Naval Postgraduate School faculty is indicated in parentheses.

The Department of Systems Management has primary responsibility for three academic programs and awards four graduate degrees. The largest program is a group of curricula in Systems Management. These curricula include Acquisition and Contract Management, Systems Acquisition Management, Financial Management, Manpower/Personnel/Training Analysis, Material Logistics Support, Systems Inventory Management, Transportation Logistics Management and Transportation Management. Graduates of these curricula are awarded the degree Master of Science in Management. This degree is accredited by the National Association of Schools of Public Affairs and Administration (NASPAA).

The other two programs for which the department is responsible are the Information Technology Management Curriculum, whose graduates receive the degree Master of Science in Information Technology Management; and the Resource Planning and Management for International Defense Curriculum. This latter program, designed for students from allied countries, is jointly offered by the Systems Management and National Security Affairs departments. Its graduates receive the degree Master of Science in International Resource Planning and Management.

The Department currently has four microcomputer laboratories available for student and faculty use. Two laboratories equipped with networked PC's and Apple Macintosh computers are used for both instructional and research purposes. A software metrics research laboratory is also available. Finally, a UNIX-based multimedia laboratory for courseware development was established in 1994.

MASTER OF SCIENCE IN INFORMATION TECHNOLOGY MANAGEMENT

A candidate for the degree of Master of Science in Information Technology Management must successfully complete or validate core courses in each of the following disciplines:

Accounting and Financial Management
 Organization Sciences
 Information Systems
 Computer Science
 Economics
 Management Theory and Practice Quantitative Methods

In addition, each candidate's curriculum must include the successful completion of 48-quarter hours of graduate-level course work and an acceptable thesis or project. At least 12-quarter hours of the course work must be at the 4000 level. Further, this graduate-level course work must include at least 24-quarter hours in Systems Management and at least 16-quarter hours in Computer Science.

MASTER OF SCIENCE IN MANAGEMENT

The degree Master of Science in Management requires:

- 1) Completion or validation of the Management Fundamentals program, which consists of a total of 32-quarter hours of 2000 and 3000 level courses, including a minimum of the following hours by disciplines:

| | |
|-------------------------------------|---|
| Accounting and Financial Management | 6 |
| Economics | 6 |
| Organization and Management | 6 |
| Quantitative Methods | 8 |

- 2) In addition to the above, completion of a minimum of 48 hours of graduate-level courses, at least 12 hours of which are at the 4000 level.
- 3) The completion of an approved sequence of courses in the student's area of concentration.
- 4) The submission of an acceptable thesis on a topic previously approved by the Department of Systems Management.
- 5) Final approval of a program from the Chairman, Department of Systems Management.

MASTER OF SCIENCE IN INTERNATIONAL RESOURCE PLANNING AND MANAGEMENT

The degree Master of Science in International Resource Planning and Management will be awarded at the completion of an inter-disciplinary program that satisfies the following requirements:

) A minimum of 48-quarter hours of graduate-level work, of which at least 12-quarter hours must represent courses at the 4000 level.

) The program must consist of a minimum of credit by discipline as follows:

| | |
|---|----|
| Accounting, Financial Management, and Economics | 24 |
| Organization and Management | 20 |
| Domestic and International Policy Studies | 24 |

) In addition to the 48-quarter hours of graduate-level course credit, an acceptable thesis must be completed. Each thesis shall have an advisor and a associate advisor, at least one of whom must be from either the Department of Systems Management, or the Department of National Security Affairs.

) The program must be approved by the Chairman, Department of Systems Management and the Chairman, Department of National Security Affairs.

DOCTOR OF PHILOSOPHY IN SYSTEMS MANAGEMENT

The Department of Systems Management has a program leading to the degree Doctor of philosophy. Areas of specialization for doctoral studies are Information systems, organization and management. Each students's program is tailored to his or her individual interests, within an overall set of requirements for the PhD degree established by the Naval Postgraduate School and the Department. Completion of the program is expected to take a minimum of three years of full-time study and research for a student entering with a baccalaureate degree. Typically, about half that time will be devoted to course work and directed study in preparation for a comprehensive qualifying examination. The other half of the time will be devoted to conducting and defending a high-quality original research effort (doctoral dissertation). For more information on the program or application procedures, please contact Chairman, Systems Management. It should be noted that all applicants must take the Graduate Management Aptitude Test (GMAT).

COURSE OFFERINGS

MS3610 MICROECONOMICS FOR OPERATIONS RESEARCH. (4-0).

Basic concepts involved in the decision processes of individuals and groups faced with scarcity of resources. Topics include consumer theory and demand, producer theory and supply, market structures, partial and general equilibrium analysis, welfare analysis, and optimal investment decision rules. Applications focus on DoD's roles as demander and supplier of resources. A required course for 360 and 361 curricula.

PREREQUISITES: MA3110 and OA3201

MS4613 THEORY AND PRACTICE OF SYSTEMS ANALYSIS (4-0)

Systems analysis (cost-effectiveness analysis) formulated as capital investment decision models. Topics include the nature of opportunity costs, theory of the second best, the social discount rate, methods of risk assessment, modeling, and solution computation. Planning and control models emphasizing decentralization of the decision problem are so addressed. DoD cost effectiveness models are examined, and institutional procedures and processes of DoD, such as PPBS, FYDP, and DAB, are discussed. No commercial text is available, therefore readings are based upon an NPS-developed package. PREREQUISITE: AS3610

MS0001 SEMINAR FOR INFORMATION TECHNOLOGY MANAGEMENT

STUDENTS. (NO CREDIT) (0-2). Guest lectures. Thesis and research presentations.

MS0123 COMPUTER SKILLS DEVELOPMENT (NO CREDIT) (0-2).

An introduction to the use and operation of microcomputers with emphasis on applications in the systems management. Exposure to pertinent software packages. Graded on a Pass/Fail basis only.

IS0810 THESIS RESEARCH FOR INFORMATION TECHNOLOGY MANAGEMENT STUDENTS. (0-8).

Every student conducting thesis research will enroll in this course.

IS2000 INTRODUCTION TO INFORMATION TECHNOLOGY MANAGEMENT (3-1)

This course will provide an introduction to the field of Information Technology management processing and the functions and responsibilities of the information technology manager.

IS3000 DISTRIBUTED COMPUTER SYSTEM. (4-1).

This course covers the technology, application and management of distributed computer systems. Specific topics include distributed processing, distributed data base management, communication facilities and protocols, economic and performance analysis, and managerial and organizational problems. REREQUISITES: CS2970, CS3030, and IS3171.

IS3020 SOFTWARE DESIGN (3-2).

The course is concerned with the use of structured techniques in the design and implementation of software. Topics covered include selection of programming languages, design of modules and module interfaces, testing, and program documentation techniques. The course also covers the use of software metrics for determining program size, complexity and quality. PREREQUISITES: CS2970, IS2000.

IS3100 ANALYSIS OF MICROCOMPUTERS AND MICROPROCESSORS (3-2).

A comparative analysis of popular microcomputers-hardware and software. Analyses will be made of the following elements: microcomputer architecture (IBM AT and PS/2, Macintosh, Sun workstation); microprocessors (Intel 286, 386 and 486 and Motorola 680000; bus systems, (ISA, EISA, MCA Nubus); operating systems (DOS, OS/2, Unix); applications (document preparation, network server, workstation). Comparisons will be made both within a vendor's product line and between vendors, with respect to characteristics, strengths, limitations, applications and costs. Tours of Silicon Valley microcomputer and semi-conductor plants. Student written and oral reports on comparative analyses. Some assembly language programming will be required. Microcomputers procured in DOD desktop contracts will be studied. PREREQUISITES: CS2970, CS3030, and IS2000.

IS3112 INFORMATION TECHNOLOGY MANAGEMENT IN DOD (4-1).

Consideration of DOD information technology systems and their management development of a framework for understanding and managing systems based on the Technical Architecture Framework In Information Management (TAFIM). PREREQUISITE: Secret clearance and fifth quarter standing in the ITM curriculum.

IS3170 ECONOMIC EVALUATION OF INFORMATION SYSTEMS I. (4-0).

This course reviews microeconomics concepts, including demand and supply, cost, competition, interest rates, present values and asymmetric information. Emphasis focuses on several themes underlying these concepts, including optimization, incentives, efficiency, the value of information, problem solving and strategic thinking. Defense information systems applications are stressed. PREREQUISITE: MN2155

IS3171 ECONOMIC EVALUATION OF INFORMATION SYSTEMS II. (4-1).

A major challenge to DoD information technology managers is assessing the payoff from the investment in information systems. This is a continuation of IS3170 focusing on the study of cost benefit (effectiveness) analysis and techniques for evaluating investments in information technology and managing information. PREREQUISITES: IS3170, MN2155, and OS3105.

IS3183 INFORMATION TECHNOLOGY MANAGEMENT (4-0)

A survey study of what constitutes information technology and the management aspects

of developing and maintaining systems in support of the Department of Defense and Joint Services. Technology aspects of hardware, operating system software, application software languages, database management, telecommunications and networking, system development processes, system integration, enduser computing, IT acquisition, IT organization and staffing issues, information privacy and security issues, and IT planning and strategies form the basis for management discussions. The course considers the IT management challenge : (1) Young technology, (2) Sustained and dramatic growth, (3) Growing complexity, (4) A number of fragmented sub-specialties (5) Downsizing and Re-engineering emphasis shifts the focus of applications being developed from transaction based systems to decision based systems. Issues are discussed from the perspective of the user of information systems and not that of the technologist. PREREQ: MN3105 and IS0123.

S3502 COMPUTER NETWORKS: WIDE AREA/LOCAL AREA. (3-2).

An introduction to the architecture, standard protocols, and technological advances in the computer networks, with an emphasis on internetworking and interoperability. Specific topics include open network architectures (OSI vs. DOD architecture), X.25, local area networks, TCP/IP, and a variety of distributed application services built on the client-server model. Students also gain an understanding of DDN (Defense Data Network), X.400-based DMS (Defense Message System) SDNS (Secure Data Network Service), and GOSIP (Government Open System Interconnection Profile). PREREQUISITES: CS2970, CS3030, IS2000, and OS3004.

S3503 MICROCOMPUTER NETWORKS. (3-2).

This course covers the theory, application, and operation of micro-computer networks. Students learn, evaluate, compare, and operate several contemporary microcomputer networks, such as IBM PC Net, IBM Token-Ring, Apple Computer Apple-Talk, 3Com Ethernet, mainframe emulations, and LAN internets. Student perform a variety of hands-on lab experiments on the SM department LANs to prepare them for future LAN management billets. The IEEE Local Area Network Standards will be covered. PREREQUISITE: IS3502.

S4182 INFORMATION SYSTEMS MANAGEMENT. (4-0).

This is the capstone course for the ITM curriculum. It assumes that information technology will increasingly play a vital role throughout the Department of Defense. The course deals with a broad range of management, economic, behavioral, and technical matters associated with the development and operation of effective information systems. Its primary focus is on the strategic and policy issues facing DoD management. Topics covered include IS functions and operations, systems development methodologies, the IS infrastructure and architecture, IS planning, process engineering, and technology assessment. PREREQUISITE: Status as student in the final quarter of the ITM curriculum.

S4183 APPLICATIONS OF DATABASE MANAGEMENT SYSTEMS. (4-1).

An applications-oriented introduction to database management systems technology. A survey of current database systems and approaches to database technology. Technical and administrative considerations involved in a database design and implementation project are considered. Students will be expected to design and implement an applications system using a database management package. PREREQUISITES: CS270, and IS2000.

S4184 INFORMATION RESOURCE MANAGEMENT IN DON/DOD (4-0).

This course is concerned with understanding the major aspects of information resource management (IRM) and how it is conducted in DOD and DON. Special attention will be paid to database administration and information engineering. Examples of IRM and DBA practice will be presented via case studies and by speakers with relevant expertise from the Navy, DOD, and private sector. PREREQUISITES: IS3112, IS4200, S4300, and IS4183.

IS4185 DECISION SUPPORT SYSTEMS. (4-1).

This course will introduce the principles for designing, implementing, and using computer systems that support a variety of decision making situations. The course will survey analytical techniques for decision-making under complex environments, involving single or multiple criteria decisions made under certainty as well as uncertainty. Students will be introduced to the latest computer-based systems, and exemplary applications in the latest computer-based systems, and exemplary applications in DoD, that support or involve the use of these formal methods. A group project requiring the design and implementation of a decision support system for a specific problem will provide students an opportunity to practice the concepts as well as work with current and emerging decision support tools. PREREQUISITES: IS2000, MN2155, MN3105, OS3004, and OS3105.

IS4186 INTRODUCTION TO KNOWLEDGE-BASED SYSTEMS AND ARTIFICIAL INTELLIGENCE. (4-1)

This course has two main objectives: 1) to introduce principles, applications and limitations of knowledge-based systems, including expert systems, as problem-solving tools, and 2) to introduce certain fundamental techniques, commonly employed in designing such systems, from the field of artificial intelligence. Specific topics include knowledge representation, automated reasoning, inference and search techniques, knowledge acquisition, and expert systems architectures. Hand-on experimentation and implementation of prototype systems will be encouraged. Students taking this course are expected to have a strong foundation in mathematical and analytical techniques. PREREQUISITES: IS2000 IS4185 and OS3105.

IS4200 SYSTEM ANALYSIS AND DESIGN. (4-2).

This course covers computer-based system development, including the following concepts, methodologies, tools, and techniques for: information systems requirements analysis, technical and economic feasibility studies, systems costing and data communications hardware and software trade-off evaluations and specifications, conversion, and testing. PREREQUISITES: CS2970, CS3030, IS2000, OS3105, and OS3004.

IS4300 SOFTWARE ENGINEERING AND MANAGEMENT. (3-2).

The objective of this course is to educate the student in areas of great concern to the Department of Defense in the fields of software engineering and management. The course examines both the technological tools of software production as well as the software engineering techniques for software project management. Software testing, metrics and reliability are also covered. DOD software standards and metrics programs are included. PREREQUISITES: CS3030, IS3020, IS3171, and OS3004.

IS4320 DATABASE AND INFORMATION RESOURCE MANAGEMENT FOR C3 (4-1).

This course provides an applications-oriented introduction to information systems, with a focus on database management. It will survey current techniques for designing and implementing database and decision support applications. Specific topics include the relational data model, use of SQL (structured query language), database administration, and the role of database and decision support tools in information management in the DoD. Students will be expected to implement a prototype database or decision support system focusing on a C3 application. PREREQUISITE: A Software Design course.

IS4502 TELECOMMUNICATIONS NETWORK (3-2).

Evaluation and analysis of technological advances, market dynamics, and regulatory trends in the telecommunication industry, giving students an understanding of current and future telecommunication services, applicable standards, and underlying motivations. Topics to be covered include PSTN (Public Switched Telephone Network), Intelligent Network, TI/T3 Networking, ISDN, Broadband Switching Services, and PCS (Personal Communication Services). All these topics lead to an understanding of the Department of Defense's new telecommunication architecture, DISN (Defense

Information Systems Network), which will serve as an integrated infrastructure for the command and control functions on a global scale. PREREQUISITES: IS3502

54800 DIRECTED STUDY IN ADVANCED INFORMATION SYSTEMS (V-V).

Directed study in advanced topics in information systems of mutual interest to student and faculty member. Intended primarily to permit students to pursue in-depth subjects not fully covered in formal class work or thesis research. May be repeated for credit with a different topic. Graded on a Pass/Fail basis only.

54925 SEMINAR IN INFORMATION SYSTEMS (V-V).

Study of a variety of topics of current interest in information systems to be determined by the instructor. PREREQUISITES: A background of information systems and permission of the instructor.

IN0001 SEMINAR FOR SYSTEMS MANAGEMENT STUDENTS. (0-2).

Guest lectures. Thesis and research presentations.

IN0810 THESIS RESEARCH FOR SYSTEMS MANAGEMENT STUDENTS. (0-8).

Every student conducting thesis research will enroll in this course.

IN2031 ECONOMIC DECISION MAKING. (4-0).

This is a course in macroeconomics. It starts with a brief introduction to microeconomics—scarcity, production possibility curves, and supply and demand. It then proceeds to topics in macroeconomics: which include national income determination, inflation, unemployment, deficits, and the banking system. Also covered are the various schools of thought in macroeconomics: Keynesian, monetarist, rational expectations, and supply side. PREREQUISITE: MA2300 (concurrently).

IN2039 BASIC QUANTITATIVE METHODS IN ECONOMIC ANALYSIS (4-0).

This course simultaneously introduces economics and the mathematical basis required for advanced economic analysis. Math topics include algebra, graphs, differential calculus, including both single and multiple variable functions, and indefinite and definite integrals. Economics concepts include demand and supply, market equilibrium, marginal analysis and unconstrained and constrained optimization. PREREQUISITE: college algebra or consent of instructor.

IN2111 SEMINAR IN MANPOWER, PERSONNEL, AND TRAINING ISSUES I. (0-2).

An introduction to the major issues, theory, and practice of the military MPT system. Graded on a Pass/Fail basis only.

IN2112 SEMINAR IN MANPOWER, PERSONNEL, AND TRAINING ISSUES II. (0-2).

An introduction to training issues and technologies and their application in the military setting. Graded on a Pass/Fail basis only.

IN2150 FINANCIAL ACCOUNTING (4-0).

Study of basic accounting concepts and standards for reporting an organization's results of operations, financial position and cash flows. Specific topics include the accounting cycle, asset valuation, recording of liabilities and capital structure, and financial statement analysis. Includes discussion of the Defense Finance and Accounting Service and the Federal Accounting Standards Advisory Board.

IN2155 ACCOUNTING FOR MANAGEMENT. (4-0).

Study of the fundamentals of financial and managerial accounting. Brief introduction to financial accounting stressing accrual concepts and the content and analysis of financial statements. More in depth focus on management accounting topics, including costing techniques for products and programs, use of cost information for decision making, capital budgeting, and financial performance measures. Applications of managerial accounting tools to DoD situations. (May not be substituted for MN 2150 and MN3161.)

MN2302 SEMINAR FOR ACQUISITION AND CONTRACTING STUDENTS. (0-2)
This course brings both Government and defense industry contract managers into the academic forum for interaction with students. Visits to Government facilities and defense plants. Thesis and research presentations. Preparation for Certified Professional Contracts Manager (CPCM) certificate examinations. Graded on a Pass/Fail basis.

MN2303 SEMINAR FOR PROGRAM MANAGEMENT STUDENTS. (0-2).
This course brings both Government and defense industry acquisition/program managers into the academic forum for interaction with students. Guest lecturers include program executive officers, program managers, laboratory and field personnel, OSD officials, congressional members and staff personnel, and defense industry representatives. Visits to Government facilities and defense plants. Thesis and research presentations. Graded on a Pass/Fail basis.

MN3105 ORGANIZATION AND MANAGEMENT. (4-0).
This course gives officers a knowledge of key concepts from management theory, organization theory, organizational behavior and organizational development. Special emphasis is given to the ability to apply these concepts in an integrated fashion to management situations in DoD/DoN. Towards that end, the course makes extensive use of multiple theoretical frames, open-systems models, and DoD/DoN case studies.

MN3111 PERSONNEL MANAGEMENT PROCESSES. (4-0).
A broad coverage of human behavior in the work situation, with key emphasis on the issues of work in the Naval environment. Topical areas covered include selection, placement, training development, and evaluation of personnel; motivation, remuneration, morale, supervision, and working conditions in military organizations; job design and organization development within complex military bureaucracies; equipment design and man-machine interface, and the impact of technological programs within the military. PREREQUISITES: MN3105 and OS3101 (concurrently) or equivalent.

MN3123 MILITARY SOCIOLOGY. (4-0).
An exploration of classical theories of sociology pertaining to civilian-military relations with modern applications to command and control problems. Sexism, racism, family dissolution, unionization, bureaucratic inertia, career patterns, professionalism and other topics are considered from the perspective of sociology and implications for the military are examined in depth. PREREQUISITE: MN3105.

MN3140 MICROECONOMIC THEORY. (4-0).
This course reviews traditional microeconomics concepts, including demand, cost, perfect and imperfect competition public goods, externalities, and factor markets. Emphasis focuses on several themes underlying these concepts, including optimization, incentives, efficiency, problem solving and strategic thinking. Defense applications are stressed. PREREQUISITES: MA2300 or MN2039 and MN2031.

MN3154 FINANCIAL MANAGEMENT IN THE ARMED FORCES (4-0). Focuses on financial management practices and concepts in DoD, with an emphasis on the Department of the Navy. Topics include appropriations, PPBS, budget formulation, review and execution, flow of funds, and accounting terminology and systems. Current financial management issues such as DFAS, DBOF and unit costing are reviewed. In-class exercises and case studies are used to develop the students ability to apply financial management concepts to real life situations. Guest speakers from the DoD/DoN financial management community provide up to date information and viewpoints. PREREQUISITES: MN2155 or MN3161.

MN3161 MANAGEMENT ACCOUNTING. (4-0).
Introduction to the concepts and systems of cost determination. Emphasis is placed on translating cost concepts into a military environment and relating them to pertinent

MB Circulars and Defense Instruction on Economic Analysis. Topics covered include b costing systems, overhead accounting and allocation, standard costs for control, exible budgeting, cost-volume-profit analysis, performance analysis, cost analysis for ructured and unstructured decision-making, and long-term investment analysis.
PREREQUISITE: MN2150.

MN3172 PUBLIC POLICY AND BUDGETING (4-0).

This course analyzes federal fiscal policy with emphasis on resource decision making for ational defense. The roles of principal budget process participants are examined. xecutive especially DoD and OMB and congressional budget processes are assessed to dicate how national security policy is implemented through fiscal policy. Spending for ational security is tracked from budget submission through budget resolution, uthorization and appropriation. Budget formulation, negotiation, and execution strategies are evaluated to indicate the dynamics of executive-legislative competition ver resource allocation priorities.

MN3221 PRINCIPLES OF PROGRAM MANAGEMENT I. (6 weeks accl course).

(4-0). This course introduces the fundamental principles of DoD sytems acquisition and rogram management by examining acquisition policy issues; planning, programming, nd budgeting processes; acquisition strategies; contractual decisions; end program anagement philosophies, issues and concepts. The aspects of planning, organizing, affing, directing and controlling within the program structure will be examined. Key nctional areas are explored including; research & development, test and evaluation, ntracting, funding and budgeting, integrated logistics support, systems engineering nd legal issues. PREREQUISITE: None.

MN3222 PRINCIPLES OF MANAGEMENT II (3-2).

This course broadens the student's understanding of the principles of DoD systems acquisition and program management gained in MN3221 by examining program anagement characteristics and competencies, control policies and techniques, systems alysis methods, and functional area concerns. Techniques for interpersonal lationships will be examined in exercise settings. The course structure concentrates a the activities occuring during the major milestones and acquisition phases including ncept exploration, demonstration and validation, engineering and manufacturing and oduction/deployment. Cases involving key planning documents, activities and phase at criteria area are examined. PREREQUISITE: MN3221.

MN3301 SYSTEMS ACQUISITION AND PROGRAM MANAGEMENT. (4-0).

This course provides the student with an understanding of the underlying philosophies nd concepts of the defense systems acquisition process and the practical application of fense program management methods within this process. Topics include the olution and current state of defense systems acquisition management; the defense ystems acquisition cycle; user-producer acquisition management disciplines and ctivities; and program planning, organizing, staffing, directing, and controlling. mphasis is on major defense acquisition cases.

MN3303 PRINCIPLES OF ACQUISITION AND CONTRACT MANAGEMENT.

(4-0). This course is an introduction to the principles of Government acquisition and ntracting. It presents the fundamentals of the Federal Acquisition Regulation (FAR) nd the DOD FAR Supplement; the Federal acquisition and contracting processes, cluding requirements determination, acquisition strategies, Government contract law, hics, contract types, contracting methods, and acquisition/contract management hniques. Emphasis is on the unique aspects of defense acquisition and contracting.

MN3304 CONTRACT PRICING AND NEGOTIATIONS. (5-2).

This course involves the study and application of pricing theory and strategies, cost ethods, defense cost and price analysis, cost principles, Cost Accounting Standards, nd contract negotiations as used in DOD. Students develop and sharpen negotiating ills by participating in practical negotiation exercises with Defense corporations.
PREREQUISITES: MN3140 and MN3303.

MN3305 CONTRACT ADMINISTRATION. (3-0).

This course stresses the management skills and techniques necessary for the successful administration of Government prime contracts and subcontracts. Topics include the DOD structure for managing contract progress and performance, change control, quality control, cost/financial control, Government property, terminations, and regulatory and policy considerations. PREREQUISITES: MN3304 and MN3312

MN3306 ACQUISITION MANAGEMENT (3-0).

This course focuses on the problem-solving and decision-making functions involved in the pre-award competitive proposal contracting phase with an emphasis on requirements determination, acquisition planning, source selection, and contract negotiation and award. Case studies and practical exercises are used to concentrate on typical problems and issues which arise in the pre-award process. Specific topics include: the acquisition process, forecasting requirements, ethics/standards of conduct, cost estimates, subcontracting, acquisition plans, contract strategies and types, specifications, statements of work, technical data, technology transfer, competition, source selection planning, market research, source selection evaluation factors, factfinding and negotiations, best and final offers, and contract award and notification. PREREQUISITE: MN3303.

MN3307 ADP ACQUISITION. (4-0).

This course is an introduction to the management principles, concepts, and issues involved in Federal Government acquisition of ADP requirements and Federal Information Processing (FIP) resources. The course focuses on the concepts of systems acquisition and program management, as they pertain to Government ADP/FIP acquisition and specific purchases of DOD computer hardware and software.

MN3309 ACQUISITION OF EMBEDDED WEAPON SYSTEMS SOFTWARE (4-0).

This course focuses on the key aspects of mission critical computer resources with particular emphasis on major weapon systems embedded software. The course analyzes software development, software risk management, software in the systems acquisition life cycle, software metrics, contracting methods for software, software test and evaluation, and software configuration management. Case studies, reports, software specifications and standards, and other similar documents/materials are used. The course addresses the underlying management principles involved in defense software acquisition. Significant software acquisition issues and problems are examined and solutions developed. PREREQUISITE: MN3301.

MN3311 PROGRAM MANAGEMENT EXERCISE (1-2).

This course requires the student to contend with many of the current "real world" issues encountered during the systems acquisition life cycle through participation in the defense management simulation called Systems Acquisition For Executives (SAFE). This computer-assisted exercise requires the student to apply his/her analytical ability and knowledge to a sequence of program management decisions made during the acquisition of a hypothetical U.S. Army surface-to-surface conventional warhead tactical missile system called "Zebra". As part of a program management team, the student will experience critical decision-making under conditions of risk and uncertainty, within the constraints of performance, schedule and cost. Students will be able to demonstrate their understanding of typical engineering, budgeting and contracting trade off analysis needed throughout the acquisition cycle from concept exploration through production/deployment. Students will be required to draft and present formal issues Papers. PREREQUISITES: MN3301, MN3371.

MN3312 CONTRACT LAW (3-0).

This course examines the legal structure within which Federal Government contracts with private industry are formulated and executed. The course addresses the unique aspects of Government contract law including such topics as agency authority, contract interpretation, disputes and remedies, socio-economic laws, labor law, property, patent and data rights, conflicts of interest, protests, and ethics. Comparisons are made with

the Uniform Commercial Code (UCC). Emphasis is on the use of Armed Services Board of Contract Appeals (ASBCA) cases. PREREQUISITE: MN3303.

MN3333 MANAGERIAL COMMUNICATION SKILLS IN THE DOD ENVIRONMENT. (4-0).

This course provides DoD and International military officers and civilians with the communication strategies and skills needed to manage and lead in the dynamic DoD environment. Instruction focuses on writing informative and persuasive documents, giving succinct, easy-to-understand briefings, managing team communication processes, developing associates' communication competencies through various feedback roles and strategies, and listening analytically and empathetically. DoD cases, scenarios, and readings are used to analyze complex communication situations unique to the military.

MN3334 MANAGERIAL COMMUNICATIONS LAB FOR INT'L STUDENTS. (0-1).

This lab complements MN3333 and is specifically designed to provide practice in oral and written communications for Allied Officers. It is particularly useful in helping students identify culturally specific differences in organization and style for oral and written communications. Furthermore, students receive highly individualized instruction to help them complete managerial communications assignments.

MN3371 CONTRACTS MANAGEMENT AND ADMINISTRATION. (4-0).

This course is a study of procurement planning, negotiation, and contract administration, including the determination of need, basic contract law, methods of procurement and fundamentals of management techniques. Topics include procurement organizations, procurement by sealed bidding and competitive negotiation, source selection, pricing, types of contracts, negotiating techniques, structuring incentives the terms and conditions of contracts, managing contract progress, total quality management, change control, cost and schedule control, contract termination, dispute situations, and international contracting issues.

MN3372 MATERIAL LOGISTICS. (4-0).

An overview of material logistics emphasizing trade-off analysis and the total cost concept of logistics. Topics include forecasting, customer service level optimization, inventory management, transportation, warehousing, facilities location, and the potential trade-offs within and between all of these areas. The similarities and differences between PREREQUISITES: MA2300 (or equivalent) and OS3101.

MN3373 DOMESTIC TRANSPORTATION MANAGEMENT (4-0).

Analysis of domestic U.S. transportation systems from a managerial perspective with an emphasis on freight service. After introducing fundamental transportation concepts and an overview of urban and passenger transportation, the course focuses on an analysis of the individual freight modes followed by an examination of intermodal services. Topics include the overall logistics context of freight service; carrier and modal competition; regulatory and legal considerations; demand, cost and pricing analysis; and managerial resource problems. Carrier and shipper decision perspectives are both developed in general and then related to the DOD as a provider and consumer of freight service. This course also introduces the student to both the commercial and defense transportation professional literature. PREREQUISITES: MN3140

MN3374 PRODUCTION MANAGEMENT: A TQM/L PERSPECTIVE (4-0).

Qualitative issues and quantitative techniques for contemporary production/operations management (POM). Qualitative issues covered include the fundamentals of total quality management/leadership, strategic considerations for quality (e.g., automation versus streamlined flow of materials) and synchronized operations (e.g., JIT techniques). Quantitative techniques include monitoring quality, forecasting, queueing, facilities planning, aggregate planning and scheduling. Actual applications of these concepts at Naval Aviation Depots and Naval Shipyards are described. Examples are included which illustrate application to DOD production and service activities. PREREQUISITES: OS3006

MN3375 MATERIALS HANDLING SYSTEMS DESIGN (4-0).

A study of the principles and system concepts of materials handling and their application in the design of a materials handling system. Such systems are an essential part of an efficient military logistics organization. The Navy's NISTARS system is examined in detail. Materials handling in Desert Shield/Storm as well as materials handling on Strategic Sealift Ships are examined. A variety of current DOD materials handling problems are discussed.

MN3377 INVENTORY MANAGEMENT. (4-0).

This course examines the organizations, functions, processes and resources that must be integrated to effectively manage DON and DOD inventories. We will study parts of requirements determination, configuration tracking, distribution, warehousing, procurement, transportation, requisitioning, and financial management systems as they apply to military inventories. PREREQUISITES: MA2300 (or equivalent) and OS3101.

MN3760 MANPOWER ECONOMICS I. (4-0)

An introduction to the theoretical aspects of labor economics. Concepts covered include the supply of labor, the demand for labor, wage determination, internal labor markets, human capital, earnings functions, turnover, compensation systems, and compensating wage differentials. Special readings are used that apply the principles to military manpower. PREREQUISITE: MN3140

MN3801 TECHNOLOGY TRANSFER. (4-0).

The study of dissemination and utilization of technology and associated problems, with emphasis on communications, sociology, and organizational factors. Course uses in-depth recent case studies to examine technology transfer issues of concern to the military. Also relies on guest speakers from military and private sector organizations. PREREQUISITE: MN3105 or permission of the instructor.

MN3805 TOTAL QUALITY LEADERSHIP AND THE MILITARY (2-0).

This course introduces the basic concepts and principles of Total Quality Leadership/Management and discusses their application to the military setting. The different service approaches and initiatives are reviewed, and examples and cases from a variety of military organizations are examined. Emphasis is placed on: the teachings of Dr. W. E. Deming, use of a systems perspective, process orientation and fact-based decision making to lead and manage a military organization, the difference between problem solving and process improvement, applying the scientific method and basic statistical and planning tools to process management and improvement, and how the concept of customer-supplier relationships translates into a military environment. PREREQUISITE: MN3105 or permission of the instructor.

MN3900 READINGS IN SYSTEMS MANAGEMENT. (4-0).

An individualized program of readings and study in some area of the systems management, designed to meet the student's special educational needs. PREREQUISITES: A background in the area of study and departmental approval. Graded on a Pass/Fail basis only.

MN3902 MPT COMPUTER SKILLS ENHANCEMENT. (0-2).

An introduction to data analysis using a computer. Topics include methods of file creation, storage, and transfer. Elementary programming concepts are introduced using a statistical software package.

MN4105 STRATEGIC MANAGEMENT (4-0).

Study and analysis of complex managerial situations requiring comprehensive integrated decision making. Topics include operational and strategic planning, policy formulation, executive control, environmental adaptation and management of change. Case studies in both the public and private sectors are used. Particular attention is given to strategic management in the military context, and in the challenging DoD,

ON organizations. PREREQUISITE: Open only to students in the final quarter of a system Management curriculum, or Information Technology Management.

IN4106 MANPOWER/PERSONNEL POLICY ANALYSIS. (4-0).

Study and analysis of military manpower/personnel policy alternatives with emphasis on identifying the trade-offs involved, the dynamic impact of major policy decisions and the short-term and long-term consequences of decisions. Review, use and evaluation of jobs to aid in selecting policy alternatives. Study of representative cases in the DoD and military services.

IN4110 MULTIVARIATE MANPOWER DATA ANALYSIS I (4-1)

An introduction to multivariate data analysis using the linear regression model. Topics include hypothesis testing, the organizations and analysis of large scale data bases, model specification issues, multicollinearity, dummy variables, forecasting, and estimation of binary choice models. Students apply techniques to Navy and DOD manpower databases developed at NPS. PREREQUISITE: A course in statistics.

IN4111 MULTIVARIATE MANPOWER DATA ANALYSIS II. (4-1).

An introduction to the specialized multivariate techniques used for analysis of military manpower data. Topics include an introduction to study design and sampling theory, maximum likelihood estimation, techniques for analyzing limited dependent and qualitative data, selection bias, time series data, and simultaneous equations models. Students apply techniques to Navy and DOD manpower databases developed at NPS. PREREQUISITE: A course in statistics.

IN4112 PERSONNEL TESTING AND SELECTION (4-0).

Study of methods available for evaluating and predicting training and work performance in organizations like the Navy: employment interviewing, testing, life-history data, and rating scales, with some reference to job analysis and recruitment. Special emphasis on testing concepts and models particularly in relation to the computerization of the Armed Services Vocational Aptitude Battery, equal employment opportunity, and selection decisions based on cost benefit analysis. PREREQUISITE: IN 4110 or equivalent with approval of instructor.

IN4114 SOCIOLOGICAL AND PSYCHOLOGICAL PERSPECTIVES ON MILITARY SERVICE (4-0).

Exploration of the concepts, theories, and methods of military sociology and military psychology as applied historically and in the current setting. Study of the military as a social institution, focusing on the internal organization and practices of the armed forces as well as the relationship between the military and society. Review and evaluation of the psychological principles employed in a variety of military areas such as health care, selection and job classification, human factors, organizational systems, personnel security, and performance appraisal. Emphasis on representative cases in DoD and the armed forces. PREREQUISITE: MN3105. Curriculum option for MPTA 347) students, who are given priority enrollment.

IN4115 TRAINING FOUNDATIONS AND MANAGEMENT (4-0).

Analysis of issues in DoD training and education. Major course themes focus on understanding military education and training from a systems perspective; analyzing instructional program design, implementation, and technologies; and applying methods of needs analysis and program evaluation. Guest speakers, military publications, student cases, and discussion based on the experience of the instructor and the students are utilized to maintain the necessary focus on current military applications.

IN4117 JOB ANALYSIS AND PERSONNEL TRAINING. (4-0).

Study of job analysis and its use in determining training requirements. Consideration of instructional systems development and training pipeline management. Attention to post-benefit issues involving training in regard to selection, equipment design, changing job requirements, and career development. PREREQUISITE: MN3111.

MN4119 SEMINAR IN MANPOWER ANALYSIS. (V-0).

Study of a variety of topics of current interest in military manpower analysis , to be determined by the instructor. PREREQUISITES: A background in manpower analysis and permission of the instructor.

MN4121 ORGANIZATION THEORY. (4-0).

Study of the major theories of modern organizations. This course emphasizes the analysis of organizational phenomena from multiple perspectives, using theories of individual, group, and organizational behavior. Topics include organization design and culture, political analysis of organizations, management of change, open systems theory, and contingency theories. PREREQUISITE: MN3105.

MN4122 PLANNING AND CONTROL: MEASUREMENT AND EVALUATION. (4-0).

Theory and techniques of the managerial functions of planning and control in both governmental and private sector organizations. Emphasis is placed on the effects of the planning and control structure on the behavior of human components of the system. Examples are drawn extensively from the governmental sector. Topics include the problems associated with the utilization of surrogates for measurement purposes, the analysis of the influence of assumptions, values, and objectives on the planning and control process, budgeting, forecasting, performance evaluation, and the reward structure. PREREQUISITE: MN4161

MN4125 MANAGING PLANNED CHANGE IN COMPLEX ORGANIZATIONS. (4-0).

Examination of the approaches to planning and managing change efforts in complex social systems made up of the interdependent components of technology, structure, task, and people and of the role of the manager or staff specialist and the process of helping. Emphasis is placed on strategies and technologies for diagnosis and planning aimed at effective implementation. Opportunities for practice using both simulations and actual organizational cases. Particular emphasis is placed on the DOD, DON organizations and the special problems they have in bringing about change. PREREQUISITE: MN3105.

MN4127 SEMINAR IN ORGANIZATION BEHAVIOR. (V-0).

Study of a variety of topics of current interest in organization behavior, to be determined by the instructor. PREREQUISITES: A background in organization behavior and permission of the instructor.

MN4145 POLICY ANALYSIS. (4-0).

The course continues MN3140. It introduces advanced microeconomics concepts, including cost benefit analysis, risk, strategic interactions and imperfect information. These concepts are used to analyze public policy issues, stressing defense-related resource allocation problems. These applications emphasize optimization, incentives, efficiency, problem solving and strategic thinking. PREREQUISITES: MN3140, mn3161, and OS3101 or equivalent.

MN4151 INTERNAL CONTROL AND AUDITING. (2-0)

Study of the objectives and techniques of internal control systems and of audits of financial reports and records and of government operations as required by Government Auditing Standards. Specific topics include the design and evaluation of internal control systems, audit reports, auditing standards, audit evidence and audit tests. PREREQUISITE: MN3161.

MN4152 CORPORATE FINANCIAL MANAGEMENT. (4-0).

The management of the finance function in industry, with particular attention to defense contractors and Navy and Defense revolving funds. Specific topics include cash and working capital management, long-term financing, and determination of optimal capital structure. PREREQUISITE: MN3161

IN4153 SEMINAR IN FINANCIAL MANAGEMENT. (V-0)

Study of a variety of emerging financial management topics that impact the Navy's planning, operations, and budgeting. This may include field case studies within the Navy or Defense organizations or discussion of new Congressional, Defense, or Navy financial management policies. Topics and prerequisite background are determined by the instructor. PREREQUISITE: Requires permission of the instructor.

IN4159 FINANCIAL REPORTING AND ANALYSIS. (4-0)

Advanced study of fundamental accounting concepts underlying published financial reports. Emphasis is placed on the evaluation of financial reporting approaches and measures from the perspective of managers and users of financial information. Topics include accounting policies and standards, alternative bases of valuation, alternative concepts of earnings, and discussion of controversial financial reporting questions. Course project investigating financial reporting issues in DoD settings. PREREQUISITE: MN3161

IN4161 MANAGEMENT CONTROL SYSTEMS. (4-0)

Study of the design, implementation, and evaluation of management planning and control systems in Navy and Defense organizations with comparisons to large, complex private sector organizations. Specific topics include the need for planning and control, strategic planning, the resource allocation process, organization of the management control function, measurement of inputs and outputs, pricing government services programming, budgeting, reporting, and performance evaluation. PREREQUISITES: MN3105 and MN3161.

IN4162 COST MANAGEMENT (4-0)

Review of basic standards, policies, and analytical techniques for identification, measurement, and reporting of cost information. In-depth study of alternative cost accounting systems, allocation of direct and indirect costs to cost objectives, activity-based costing and special problems of accounting for materials, labor and overhead costs. Specific attention is given to Navy and Defense unit costing for activities and the Defense Business Operations Fund program. Also covered are the Cost Accounting Standards for negotiated defense procurement contracts. PREREQUISITE: MN3161.

IN4163 ANALYTICAL TECHNIQUES FOR DECISION MAKING (4-0)

Study of quantitative methods most useful for DoD resource management decision making and risk analysis. Emphasis is on developing quantitative methods as decision support tools, with available computer software as computational aids. Covered are pertinent segments of DoD Instruction 7041.3, "Economic Analysis and Program Evaluation for Resource Management," relevant quantitative techniques for decision analysis, the conditions for successful applications, data needed for applications, and the use of computational aids for problem solving. The goal is to provide sufficient competency for students to apply sophisticated analytical techniques to various cost analysis and estimation environments in DoD. PREREQUISITES: MN3161 and OS3101

IN4301 CONTRACTING FOR MAJOR SYSTEMS. (4-0).

This course is the study of the major defense contracting process, procedures, and practices. It focuses on the contracting process of the Service Systems Commands and the major defense acquisition process. Topics include contracting organizations for systems acquisition, systems acquisition process, business clearance process, source selection, multi-year procurement, pricing, and administration of major systems contracts. Related topics include funding, reliability/maintainability, integrated logistics support, research and development, test and evaluation, and congressional activity. PREREQUISITE: MN3305.

IN4302 DEFENSE RESOURCE POLICY AND MANAGEMENT. (4-0).

National defense and Navy policy formulation and execution and its impact on the defense budget. Analysis of contemporary defense policy and management issues and their resource implications. Relationships between DOD, the Navy and other military

departments, the defense industry and Congress in the policy and resource decision making process. Textbook written specifically for this course by instructor: Mission Financing to Realign National Defense. PREREQUISITE: MN3172.

MN4305 DEFENSE TECHNOLOGY POLICY (4-0).

This seminar examines the problems of identifying and acquiring U.S. military technology in the post-Cold war environment. Readings in the literature of defense technology, bureaucracy and economics explore changes in the defense technology base developments in DoD technology policy and organization, including the defense laboratories, defense conversion, foreign dependence, technology security, shifts in U.S. economic policy and assets and the evolution of global technological capabilities, especially in the Asia-Pacific region. PREREQUISITE: MN3172 or permission of instructor.

MN4307 PROGRAM MANAGEMENT POLICY AND CONTROL (4-0).

This course provides the student with knowledge and understanding of major defense systems management control processes and tools, application of program management control systems; and the use of computer-based management information systems with emphasis on real world, practical systems for performance, cost and schedule control. Case studies involving program management problem solving and decision-making in the defense acquisition environment are used. PREREQUISITE: Open only to students in the final quarter of the Systems Acquisition Management curriculum.

MN4310 LOGISTICS ENGINEERING. (4-0).

The concept of integrated logistics support and its relationships with systems engineering in the design of military weapon systems. Operational requirements, system maintenance concept, functional analysis, life-cycle costs, logistics support analysis, systems design, test and evaluation, production, provisioning and resupply of spare and repair parts are discussed. Case studies include the F/A- 18 Aviation Coordinated Allowance List (AVCAL) spare parts determination and various weapon system reliability/readiness tradeoffs. PREREQUISITE: OS3006 (concurrently).

MN4312 SIMULATION MODELING FOR MANAGERIAL DECISION MAKING (4-0).

Modeling and analysis of computer simulation for managerial decision making. Case studies of simulation applications to weapon, logistics, communications and production systems. PREREQUISITE: Introductory probability and statistics.

MN4371 ACQUISITION AND CONTRACTING POLICY. (4-0).

This course uses case studies and current acquisition issues to analyze Government and business acquisition/contracting policies. Emphasis is on defense acquisition decision-making and policy formulation/execution. PREREQUISITE: MN4301

MN4372 SEMINAR IN ACQUISITION AND CONTRACT MANAGEMENT. (V-0).

This seminar involves the study of a variety of topics of current interest in defense acquisition and contracting to be determined by the instructor. PREREQUISITE: A background in acquisition and permission of the instructor.

MN4373 INTERNATIONAL TRANSPORTATION MANAGEMENT (4-0).

Analysis of international transportation systems from a managerial perspective. Maritime economics and operations are emphasized as background for DOD/DON sealift responsibilities and operations. As a first graduate course in transportation research, this course is also designed to introduce the student to transportation research methods through the current transportation research literature, with an emphasis on critical thinking in the application of fundamental transportation concepts. Topics include carriers and users of the systems; carrier and modal competition; intermodal options; regulatory and legal considerations; demand, cost and pricing analysis; and managerial resource problems. PREREQUISITE: MN3373.

N4376 DEFENSE TRANSPORTATION SYSTEM (4-0).

Study and analysis of the structure and environment of the Defense Transportation System. Topics include strategic planning systems for warfare (e. g., GCCS and DPES), organizations providing transportation support for warfare (e. g., TRANSCOM and TCCs), the strategic lift triad and trade-offs concerning their roles and capabilities, and studies and analyses of the Defense Transportation System (e.g., RS). No commercial text is available, therefore readings are based upon an NPS-developed package. **PREREQUISITES:** An active SECRET clearance and MN4373 or consent of the instructor.

N4377 TQM/TQL: PHILOSOPHY, THEORY, TOOLS (4-0).

Deming's 14 points (philosophy and basic theory). The 7 basic graphic tools (flow charts, cause and effects diagrams, Pareto charts, histograms, scatter diagrams, run charts and control charts), which help analyze generic processes. Advanced theories and techniques, designed to address quality issues of specific types, including SMED (single minute exchange or die, or setup reduction), Poka-Yoke (mistake proofing), Synchronized Operations (also known as Just-In-Time), and Statistical Experimental methods for off-line quality improvement such as Taguchi Methods, and Group Technology. We'll discuss how these methods, developed predominantly in the manufacturing environment, can be used in services. **PREREQUISITES:** Any 3000 level course in probability and statistics.

N4500 PRODUCTIVITY ANALYSIS. (4-0).

Study of the theoretical and institutional foundations of the analysis of productivity measurement and enhancement programs in DOD. Emphasis is placed on methods of applying microeconomic and organizational effectiveness principles and concepts to the critical analysis of proposed and existing DOD productivity programs, as well as to the development of alternatives which have higher probabilities of effecting the desired increases in program effectiveness and efficiency. **PREREQUISITE:** MN 3105 and N3140.

N4650 THE MILITARY HEALTH CARE DELIVERY SYSTEM AND ANALYSIS. (4-0).

This course is designed to acquaint the student with the structure and operation of the Department of Defense's system for providing health care to those eligible under current regulations; to identify current problem areas; and, through application of systems analysis and management techniques, to address the possible solutions to these problems in a course project. **PREREQUISITE:** Permission of the instructor.

N4761 APPLIED MANPOWER ANALYSIS. (4-0).

Application of theoretical models and quantitative techniques to Navy and DOD manpower, personnel, and training issues. Topics include manpower supply models, attrition and reenlistment models, manpower requirements determination, force structure analysis, manpower productivity, and compensation systems. Course uses specialized readings in DOD and navy manpower.

N4900 READINGS IN SYSTEMS MANAGEMENT. (V-0).

An individualized program of advanced readings and study in some area of SYSTEMS MANAGEMENT. **PREREQUISITES:** A background of advanced work in the area of study and departmental approval. Graded on a Pass/Fail basis only.

MN4942 THE STRUCTURE, CONDUCT AND PERFORMANCE OF THE DEFENSE INDUSTRIES. (4-0).

A study of selected defense industries' structures (e.g., seller concentration, product differentiation, barriers to entry, demand for products, and buyer concentration), conduct (e. g., pricing policy, product characteristics policy, and policies toward rivals and customers), and performance (e.g., efficiency, progress, and employment). The government as consumer and regulator. Typical industries include aerospace, computers, shipbuilding, and telecommunications. PREREQUISITE: MN 3140 or equivalent.

MN4945 SEMINAR IN ECONOMICS. (V-0). Study of a variety of topics of current interest in economics, to be determined by the instructor.

MN4970 SEMINAR IN SYSTEMS MANAGEMENT (V-0).

Study of a variety of topics of general interest in the systems management, to be determined by the instructor. PREREQUISITES: A background in systems management and permission of the instructor.

UNDERSEA WARFARE ACADEMIC GROUP

Chairman:

James Eagle
Professor
Code UW, Root Hall
Room 201
(408) 656-2654
DSN 878-2654

Steven Richard Baker, Associate Professor (1985)*; PhD University of California at Los Angeles, 1985.

Robert Hathaway Bourke, Professor of Oceanography (1971); BS, Naval Academy, 1960; MS, Oregon State University, 1969; PhD, Oregon State University, 1972.

Hing-Sang Chiu, Associate Professor (1988); ScD, Massachusetts Institute of Technology and Woods Hole Oceanographic Institution, 1985.

James Norfleet Eagle, II, Professor of Operations Research (1983); PhD, Stanford University, 1975.

James H. Miller, Associate Professor (1987); ScD, Massachusetts Institute of Technology and Woods Hole Oceanographic Institution, 1987.

James Vincent Sanders, Associate Professor of Physics (1961); BS, Kent State University, 1954; PhD, Cornell University, 1961.

Lyde Scandrett, Associate Professor (1987), PhD, Northwestern University, 1985.

Ian Robert Washburn, Professor (1970); PhD, Carnegie Institute of Technology, 1965.

The year of joining the Naval Postgraduate School faculty is indicated in parentheses.

Academic Associate:

James Sanders, Associate Professor
Code PH/Sd, Spanagel Hall, Room 146B
(408) 656-2931, DSN 878-2931

The Undersea Warfare Academic Group is an association of faculty members presenting separate academic disciplines. An academic group is a less formal organization than an academic department and each professor in the group has an appointment in an academic department. The Undersea Warfare Academic Group has administrative responsibility for the academic content of the Undersea Warfare program of study. Teaching in this interdisciplinary program is carried out by faculty members attached to the following academic departments: Electrical and Computer Engineering, Mathematics, National Security Affairs, Oceanography, Operations Research and Physics.

MASTER OF SCIENCE IN APPLIED SCIENCE

Depending on the specialization track selected by the student, a Master of Science will be awarded in Applied Physics, Physical Oceanography, Electrical Engineering, or Applied Science.

The entire program must be approved by the Chairman of the Undersea Warfare Group.

COURSE OFFERINGS

UW0001 SEMINAR. (NO CREDIT) (0-1).

Special lectures, and discussion of matters related to the ASW Program.

PREREQUISITE: Enrollment in the UW Curriculum and SECRET clearance.

UW0810 THESIS RESEARCH GROUP/PROJECT. (0-8).

Students in the UW Curriculum will enroll in this course while doing either an individual thesis or an equivalent group project involving several students and faculty.

UW3000 STUDY PROJECT ON ASW SYSTEMS PERFORMANCE. (0-2).

This is a project course in which the project is a study and analysis of the performance of an assigned type of UW system under a variety of operating conditions.

PREREQUISITE: Enrollment in the UW Curriculum or consent of the Group Chairman and SECRET clearance. Graded on a Pass/Fail basis only.

UW4999 SPECIAL STUDIES IN UW. (V-0).

A course designed to meet the needs of students for special work in advanced topics related to UW. **PREREQUISITE:** Enrollment in the UW curriculum and consent of the Group Chairman.

DEFENSE RESOURCES MANAGEMENT INSTITUTE

- Thomas A. Mercer**, Rear Admiral, U.S. Navy; Director (1992)*; MS, NPS, 1969.
- James S. Blandin**, Professor (1974); PhD, University of Oregon, 1974.
- Donald E. Bonsper**, Senior Lecturer (1982); MS, Naval Postgraduate School, 1970.
- Robert E. Boynton**, Associate Professor (1970); PhD, Stanford University, 1968.
- Annie M. Chermak**, Assistant Professor (1992); PhD, Colorado School of Mines, 1991.
- Philip A. Costain**, Senior Lecturer (1979); MS, Naval Postgraduate School, 1971.
- Alph Cundiff**, Research Assistant (1992); BA, University of Pacific, 1977.
- John E. Dawson**, Professor (1966); PhD, Syracuse University, 1971.
- Peter C. Frederiksen**, Professor (1974); PhD, Washington State University, 1974.
- Erald M. Groshek**, Assistant Professor (1994); PhD, University of Denver, 1992.
- Michael A. Hurd**, LTCol, U.S. Army; Lecturer (1992); MSBA, Boston University, 1980.
- Stephen F. Hurst**, Lecturer (1989); MS, Naval Postgraduate School, 1985.
- Christopher M. Keller**, Assistant Professor (1991); PhD, Indiana University, 1991.
- John E. Keller**, Lecturer (1990); BA, Harvard University, 1956.
- Charles J. LaCivita**, Executive Director (1985); PhD, University of California at Santa Barbara, 1981.
- Francois Melese**, Associate Professor (1987); PhD, University of Louvain, Belgium, 1982.
- James H. Morris**, Professor (1982); PhD, University of Oregon, 1976.
- William C. Polley**, Maj. USMC; Lecturer (1992); BA, Texas Tech University, 1979.
- Avid L. Ritchie**, LCDR, USN; Lecturer (1992); Brigham Young University, 1977.
- Neil E. Seiden**, CDR, USN; Lecturer (1991); MS, Naval Postgraduate School, 1991.
- Michael D. Stroup**, Assistant Professor (1993); PhD, Florida State University, 1993.
- Harry E. Vaughan**, Lecturer (1992); MS, Naval Postgraduate School, 1974.
- Robert von Pagenhardt**, Professor (1967); PhD, Stanford University, 1970.
- Robert D. Wall**, Professor (1985); PhD, University of Minnesota, 1971.
- Patricia J. Webb**, Assistant Professor (1992); PhD, Duke University, 1992.
- William J. Wellington**, Visiting Assistant Professor (1994); PhD, University of Michigan, 1990.
- Arnold M. Whitt II**, Associate Professor (1988); PhD, Johns Hopkins University, 1977.

The year of joining the Naval Postgraduate School faculty is indicated in parentheses.

DEFENSE RESOURCES MANAGEMENT INSTITUTE

Established in 1965 as the Navy Management Systems Center and redesignated to its present title in May 1992, the Defense Resources Management Institute is a jointly

staffed U.S. Department of Defense sponsored educational institution located as a tenant activity at the Naval Postgraduate School. It conducts educational programs in resources management, both in residence at Monterey and on-site, for military officers and civilian defense officials of the U.S. and cooperating foreign nations. The focus of all programs conducted by the institute is on the development of knowledge and improvement of understanding of the concepts, techniques and application of modern defense management, with specific emphasis on analytical decision making. The mission, objectives and responsibilities of the Institute are set forth in Department of Defense Directive 5010.35.

The Institute currently offers the following resident courses within its facilities at the Naval Postgraduate School:

DEFENSE RESOURCES MANAGEMENT COURSE - Four weeks in length; presented five times per year.

INTERNATIONAL DEFENSE MANAGEMENT COURSE - Eleven weeks in length; presented twice a year.

SENIOR INTERNATIONAL DEFENSE MANAGEMENT COURSE - Four weeks in length; presented once each year (normally in the month of June).

Descriptions of these courses are provided below; detailed information on current quota, control agencies and procedures may be found in DoD Publication 5010.16-C (Defense Management Education and Training Catalog) or by calling DRMI at: Commercial (408) 656-2104, DSN 878-2104.

In addition to its regularly scheduled resident programs, the Institute also provides:

MOBILE EDUCATION COURSES - normally two or three weeks in length, for U.S. military services and defense agencies and for foreign governments upon specific request and approval.

COURSES FOR OTHER AGENCIES - programs are from two to four weeks duration, resident or on-site, for non-defense federal agencies and state and local governments, upon specific request and approval.

Faculty of the Institute are members of the faculty of the Naval Postgraduate School on assignment to the Institute.

Since 1966, over 19,000 officials, of whom more than 7,000 represented 115 foreign nations, have participated in programs conducted by the Institute.

DEFENSE RESOURCES MANAGEMENT COURSE

Military officers of all services, grades 0-4 and above, and civilian employees GS-11 and above, are eligible to attend this course. Also civilians in accelerated career development programs may attend.

The objective of this four-week course is to provide an appreciation of the concepts, principles and methods of defense management as they concern planning, programming, budgeting and related activities. Emphasis is placed on the analytical aspects of management, stemming from the disciplines of management systems, economics and quantitative analysis.

Participants are not expected to become experts or technicians in the various disciplines and subjects included in the curriculum. The objectives are to provide orientation on the overall functioning of the defense management process; insights as to what defense management requires in the way of inputs and analysis for decision making; understanding of the principles, methods and techniques used; and awareness of the interfaces between management requirements of the Defense Department components and the Office of the Secretary of Defense. Course methodology includes

ectures, small group discussions reinforced by illustrative case studies and problem sets, as well as selected daily reading assignments.

This course is primarily for U.S. officials, although limited numbers of international participants are normally also enrolled.

INTERNATIONAL DEFENSE MANAGEMENT COURSE

The course is designed for participants in the military grades of 0-4 (Major/Lieutenant Commander) through 0-6 (Colonel/Captain) and defense-related civilians of equivalent rank. Enrollment is currently limited to a maximum of 54 participants. Broad national representation is desired for this course, i.e., participation of at least 20-25 nations enhances the value of the comparative management aspects of this curriculum.

The course is presented in English.

The course provides a series of lectures in three major areas: the defense management environment, quantitative and economic analysis and management systems in the context of strategy, implementation and operations. The lectures are supplemented by small group discussions and workshops which concentrate on the lecture topics and associated readings, problems and cases. In the discussion groups, faculty members guide the interchange of ideas and are available to answer questions. Readings are assigned from within texts and supplemental material given to the participants to facilitate preparation for each lecture. Lecture outlines with additional suggested reading lists are provided. Occasional open seminar speakers are invited for special topics.

Throughout the course, the participants are encouraged to present and discuss information with respect to the defense management systems of their countries and to examine how the management concepts and techniques discussed by both the faculty and the participants from other countries may be applied in their own situations. Comparative study by means of interaction among participants is considered to be an extremely valuable characteristic of the course.

During the course, the Institute conducts a field trip to selected military and government agencies in the Washington, D.C. area. This trip provides an opportunity for the participants to receive special briefings on management techniques and problems and to observe actual practices at the operating level.

In the second half of the course, the general concepts of defense management are elaborated in detail during the examination of actual systems in financial, material and human resources management. At the end of the course, a general review integrates the formal course material, special topics and field trip experiences.

SENIOR INTERNATIONAL DEFENSE MANAGEMENT COURSE

Enrollment is restricted to military flag and general officers (grades 0-7 and above) and defense-related civilians of equivalent rank, except that for countries where the 0-6 grade is comparable to flag/general rank, such officials may be enrolled on a waiver basis.

Participation in this course is normally from 50 to 54 senior officials from as many as 35 countries.

The course is presented in English.

The lecture, small discussion group, case study and problem format and content described above for IDMC also apply, but are compressed in time. Two or three guest speakers are invited to address the class and a short field trip is conducted.

DEFENSE RESOURCES MANAGEMENT INSTITUTE FISCAL YEAR 1995

| COURSE NAME | COURSE NUMBER | LENGTH (weeks) | DATES (inclusive) |
|---|--------------------------|---------------------------|------------------------------|
| International Defense Management Course* | IDMC 94-2 | 11 | 26 SEP - 09 DEC 1994 |
| Defense Resources Management Course | DRMC 95-1 | 4 | 09 JAN - 03 FEB 1995 |
| International Defense Management Course | IDMC 95-1 | 11 | 06 FEB - 19 APR 1995 |
| Defense Resources Management Course | DRMC 95-2 | 4 | 24 APR - 18 MAY 1995 |
| Defense Resources Management Course | DRMC 95-3 | 4 | 22 MAY - 16 JUN 1995 |
| 26th Annual Senior Internationals Defense Management Course | SIDMC 95 | 4 | 26 JUN - 21 JUL 1995 |
| Defense Resources Management Course | DRMC 95-4 | 4 | 24 JUL - 17 AUG 1995 |
| Defense Resources Management Course | DRMC 95-5 | 4 | 21 AUG - 15 SEP 1995 |
| International Defense Management Course* | IDMC 95-2 | 11 | 25 SEP - 08 DEC 1995 |

* These courses convene in one fiscal year and continue into the next fiscal year.

APPENDIX A: DISTINGUISHED ALUMNI

Among those U.S. officers who have completed a curricular program at the Naval Postgraduate School, the following officers (USN unless otherwise indicated) have attained flag rank and were on the active list as of March 1995:

Admiral Stanley R. Arthur
Admiral Robert J. Kelly
Admiral Henry H. Mauz, Jr.

Vice Admiral Richard C. Allen
Vice Admiral William C. Bowes
Vice Admiral Arthur K. Cebrowski
Vice Admiral William A. Earner
Major General George A. Fisher, USA
Vice Admiral William J. Flanagan, Jr.
Vice Admiral Richard D. Herr, USCG
Vice Admiral Douglas J. Katz
Vice Admiral Thomas J. Lopez
Vice Admiral Richard C. Macke
Vice Admiral Joseph P. Reason
Vice Admiral David B. Robinson
Major General Stephen Silvasy, Jr., USA
Vice Admiral Robert J. Spane
Vice Admiral George R. Sterner
Vice Admiral Jerry L. Unruh
Vice Admiral Timothy W. Wright

Rear Admiral James F. Amerault
Rear Admiral Timothy R. Beard
Rear Admiral John J. Bepko, III
Rear Admiral David S. Bill, III
Rear Admiral Michael W. Bordy
Rear Admiral Steven R. Briggs
Rear Admiral Robert C. Chaplin
Rear Admiral Arthur Clark
Rear Admiral Vernon E. Clark
Rear Admiral Philip J. Coady, Jr.
Rear Admiral Jon S. Coleman
Rear Admiral Dennis R. Conley
Rear Admiral Michael T. Coyle
Rear Admiral Michael W. Cramer
Rear Admiral Joseph J. Dantone
Rear Admiral George W. Davis, VI
Rear Admiral Walter J. Davis
Rear Admiral James C. Dawson, Jr.
Rear Admiral Ernest A. Elliot
Rear Admiral Robert L. Ellis, Jr.
Rear Admiral James B. Ferguson, III
Rear Admiral James R. Fitzgerald
Rear Admiral John A. Gauss
Rear Admiral George N. Gee
Rear Admiral Everett L. Greene
Rear Admiral James B. Greene, Jr.
Rear Admiral Lee F. Gunn
Rear Admiral William J. Hancock
Rear Admiral Robert G. Harrison
Rear Admiral James B. Hinkle
Rear Admiral Francis K. Holian

Rear Admiral John T. Hood
Rear Admiral Lowell E. Jacoby
Rear Admiral Stephen T. Keith, USNR
Rear Admiral Edward K. Kristensen
Rear Admiral James A. Lair
Rear Admiral Irve C. Lemoyne
Rear Admiral Keith W. Lippert
Rear Admiral John A. Lockard
Rear Admiral Peter A. C. Long
Rear Admiral John T. Lyons, III
Rear Admiral Richard W. Mayo
Rear Admiral Dana B. McKinney
Rear Admiral Henry C. McKinney
Rear Admiral Thomas A. Mercer
Major General Kenneth A. Minihan, USAF
Rear Admiral Joseph S. Mobley
Rear Admiral Edward Moore, Jr.
Rear Admiral Michael G. Mullen
Major General James M. Myatt, USMC
Rear Admiral David J. Nash
Rear Admiral Robert J. Natter
Rear Admiral Larry D. Newsome
Rear Admiral Robert M. Nutwell
Rear Admiral Phillip R. Olson
Rear Admiral Paul W. Parcels
Rear Admiral John D. Pearson
Rear Admiral James B. Perkins, III
Rear Admiral Rudy K. Peschel, USCG
Rear Admiral John S. Redd
Rear Admiral Paul M. Robinson
Rear Admiral Charles R. Saffel, Jr.
Rear Admiral David P. Sargent, Jr.
Rear Admiral William R. Schmidt
Rear Admiral Luther F. Schriefer
Rear Admiral John T. Scudi
Rear Admiral Raymond C. Smith, Jr.
Rear Admiral Robert G. Sprigg
Rear Admiral Robert Sutton
Rear Admiral James L. Taylor
Rear Admiral William E. Terry
Rear Admiral Ralph L. Tindal
Rear Admiral William J. Tinston, Jr.
Rear Admiral Paul E. Tobin
Rear Admiral Patricia A. Tracey
Rear Admiral Joseph S. Walker
Rear Admiral David E. White
Rear Admiral Richard D. Williams, III
Rear Admiral Richard A. Wilson
Rear Admiral Hugh D. Wisely
Rear Admiral William H. Wright, IV
Rear Admiral George R. Yount
Rear Admiral John J. Zerr

APPENDIX B: AWARDS FOR GRADUATES

ADMINISTRATIVE SCIENCES FACULTY AWARD FOR EXCELLENCE IN MANAGEMENT

Presented semiannually to an outstanding student in Administrative Sciences at the Naval Postgraduate School in recognition of distinguished academic achievement.

ADMIRAL WILLIAM ADGER MOFFETT AWARD

This award is presented annually to an outstanding graduate of the Aeronautical Engineering program on the basis of academic excellence, including thesis and career potential.

ARMED FORCES COMMUNICATIONS AND ELECTRONICS ASSOCIATION HONOR AWARD

Presented to that officer graduate who has achieved academic excellence and best demonstrated professional qualities in one of the following programs: Electronics, Communications, Intelligence, Command and Control, or Computer Technology.

ARMY CHIEF OF STAFF AWARD FOR EXCELLENCE IN OPERATIONS RESEARCH

Presented semiannually to a U.S. Army Officer student in the Operations Analysis program who possesses an outstanding academic record, including thesis and project work, and who demonstrates qualities indicative of an outstanding military officer.

ASTRONAUT MICHAEL J. SMITH, CAPT, USN, ASTRONAUTICS AWARD

Astronaut and CAPT Michael J. Smith, who was an alumnus of NPS, gave his life exploring space for the enrichment of mankind. This award is presented annually to an outstanding graduate of the Space Systems Engineering or Space Systems Operations curricula. The award is made on the basis of the student's academic excellence, including thesis, and his career potential.

CAPTAIN JOHN C. WOELFEL AWARD

Presented each June to the outstanding Naval Engineering program officer student on the basis of academic and leadership qualities and performance. Officers from the past September, December, March and June graduation classes are considered.

CHIEF OF NAVAL OPERATIONS ANTISUBMARINE WARFARE AWARD

Sponsored by the National Security Industrial Association and presented in recognition of distinguished academic achievement to that Antisubmarine Warfare curriculum graduate who has demonstrated outstanding academic performance and exhibited those qualities indicative of an outstanding military officer.

CHIEF OF NAVAL OPERATIONS AWARD FOR EXCELLENCE IN MANPOWER, PERSONNEL AND TRAINING ANALYSIS

This award is given semiannually to U.S. Navy, or Op-01 sponsored civilian, graduate of the Manpower, Personnel and Training Analysis curriculum who has demonstrated outstanding academic performance, thesis quality and leadership potential.

CHIEF OF NAVAL OPERATIONS AWARD FOR EXCELLENCE IN OPERATIONS RESEARCH

Presented semiannually to the outstanding USN or USMC graduate of the Operations Research program on the basis of academic achievement, experience tour performance, thesis work and demonstration of those qualities indicative of the outstanding military officer.

CHIEF OF NAVAL OPERATIONS COMMUNICATIONS AWARD

Presented in recognition of distinguished academic achievement in the Communications Engineering or Telecommunications Systems programs to that graduate who has attained an outstanding academic record and who exhibits those qualities of an outstanding military officer.

CONRAD SCHOLAR AWARD FOR DISTINGUISHED ACADEMIC ACHIEVEMENT IN FINANCIAL MANAGEMENT.

Presented semiannually to an outstanding Unrestricted Line (URL) officer in the Financial Management community who has demonstrated academic excellence, presented a financial management essay for publication, and exhibited the potential for outstanding leadership while attending the Naval Postgraduate School.

DEPARTMENT OF THE NAVY AWARD FOR ACADEMIC EXCELLENCE IN FINANCIAL MANAGEMENT

This award is presented semiannually to a financial management student who demonstrates overall academic performance, academic excellence in financial management courses, high leadership potential, future ability to contribute to professional, academic and public forums while meeting the highest standards of stewardship of the national trust, and thesis excellence.

JOINT CHIEFS OF STAFF COMMAND, CONTROL AND COMMUNICATIONS AWARD

Presented to the outstanding graduate of the Command, Control and Communications program in recognition of distinguished academic achievement based upon grades obtained, quality of thesis and overall performance.

MEWBORN STUDENT RESEARCH AWARD

Presented annually to an officer student whose thesis exhibits sound scholarship and highest research ability. Criteria of selection conform as nearly as possible to the concept of "evidence of research potential" which forms the basis for election to Associate Membership in the Society of Sigma Xi.

MILITARY OPERATIONS RESEARCH SOCIETY GRADUATE RESEARCH AWARD

Presented in recognition of outstanding achievement in graduate research directed toward improving military force utilization. The primary award criterion is research which leads to demonstration of, or potential for, increased operating effectiveness of currently available or near term assets.

MONTEREY KIWANIS CLUB OUTSTANDING FOREIGN STUDENT AWARD

Presented annually, this award is based on criteria provided by the Kiwanis Club of Monterey including the following; academic standing and achievements, involvement in community affairs, motivation, demeanor and appearance, and relationship with other students.

MONTEREY PENINSULA COUNCIL NAVY LEAGUE AWARD FOR HIGHEST ACADEMIC ACHIEVEMENT

The award is presented quarterly to the graduation USN, USMC, USCG or NOAA student who has maintained an outstanding overall academic record at the Naval Postgraduate School. Excellent academic achievement, thesis research, military bearing, motivation and community involvement are the criteria for selection.

THE NAVAL POSTGRADUATE SCHOOL SUPERIOR SERVICE AWARD

This award is presented intermittently for outstanding service which would have a lasting impact on the student community and the school. The award is based on leadership, organizational abilities and the nominee should have in some way improved the life of students and the community.

NAVAL SEA SYSTEMS COMMAND AWARD FOR EXCELLENCE IN UNDERSEA WARFARE TECHNOLOGY

This award is presented annually at the March graduation ceremony to an outstanding officer student who successfully completes any curricular program and a thesis which demonstrates outstanding potential for application to Underseas Warfare Technology.

NAVAL SEA SYSTEMS COMMAND AWARD FOR COMBAT SYSTEMS EXCELLENCE

Presented in recognition of distinguished scholastic achievement in a Combat Systems related field of study. Selection is based upon marks attained, quality and applicability of thesis, and demonstrated leadership potential in the field of Weapons Engineering.

NAVAL SEA SYSTEMS COMMAND AWARD IN ELECTRONIC WARFARE TECHNOLOGY

Presented in recognition of academic achievement in the Electronic Warfare Systems Technology program to that graduate who has attained an outstanding academic record and who has exhibited outstanding leadership qualities.

NAVAL SEA SYSTEMS COMMAND AWARD IN NAVAL ENGINEERING

Presented in recognition of distinguished academic achievement in the Naval Engineering Program. The criteria for the award include: demonstrated academic excellence measured by marks attained, content of thesis and demonstrated leadership potential in Naval Engineering.

NAVAL SUPPLY SYSTEMS COMMAND AWARD FOR ACADEMIC EXCELLENCE IN ADMINISTRATIVE SCIENCES

Presented semiannually to an outstanding U.S. Navy Supply Corps officer in Administrative Sciences. This award is made on the basis of academic achievement, research excellence, contribution to the professional and civilian community, and faculty recommendation.

NAVAL SURFACE WEAPONS CENTER AWARD FOR EXCELLENCE IN SURFACE WARFARE TECHNOLOGY

Presented semiannually to a U.S. Naval officer of high academic standing whose thesis topic and quality of supporting research demonstrates the greatest potential for contribution to surface warfare.

NAVAL UNDERWATER SYSTEMS CENTER AWARD FOR EXCELLENCE IN UNDERWATER SYSTEMS TECHNOLOGY

Presented annually to the student, who by academic standing and relevance of thesis topic, has demonstrated the greatest achievement in the field of Underwater Systems Technology.

OCEANOGRAPHER OF THE NAVY AIR-OCEAN SCIENCES AWARD

Presented to a U.S. Naval Officer graduate of the Air-Ocean Sciences program who has demonstrated outstanding performance and exhibited those qualities indicative of an outstanding military officer.

THE OUTSTANDING ACADEMIC ACHIEVEMENT AWARD FOR DEPARTMENT OF DEFENSE STUDENTS

Presented quarterly to the graduating USA, USAF or DoD civilian student who has maintained an outstanding academic record at the Naval Postgraduate School based on the same criteria as the Navy League Award.

THE OUTSTANDING ACADEMIC ACHIEVEMENT AWARD FOR INTERNATIONAL STUDENTS

This award is presented quarterly on the basis of outstanding achievement in the areas of academic achievement, thesis research, military bearing, motivation, community involvement and relationship with other students.

REAR ADMIRAL GRACE MURRAY HOPPER AWARD FOR COMPUTER TECHNOLOGY

Presented semiannually to the outstanding Computer Science and Information Technology Management officer on the basis of thesis quality, academic performance and demonstrated leadership ability in the study of computer technology.

REAR ADMIRAL THOMAS R. MCCLELLAN AWARD FOR ACADEMIC EXCELLENCE IN ADMINISTRATIVE SCIENCES

Presented to a graduate of Administrative Sciences from the aviation community, based upon academic performance, professional commitment and leadership potential.

SPACE AND NAVAL WARFARE SYSTEMS COMMAND AWARD IN ELECTRONICS SYSTEMS ENGINEERING

Presented semiannually to a U.S. Naval Officer Student in recognition of distinguished academic achievement in the advanced Electronics Engineering program.

THE SPACE AND NAVAL WARFARE SYSTEMS COMMAND AWARD IN ELECTRONIC WARFARE TECHNOLOGY

Presented in September to the Naval Postgraduate School student graduating in the Electronic Warfare Systems Technology curriculum who possesses an outstanding academic record, including thesis work, and exhibits outstanding leadership qualities.

THE SPACE SYSTEMS ENGINEERING AWARD FOR ACADEMIC EXCELLENCE

Presented annually to an outstanding student in Space Systems Engineering program in recognition of distinguished academic achievement based upon grades obtained, quality of thesis and overall performance.

THE SPACE SYSTEMS OPERATIONS AWARD FOR ACADEMIC EXCELLENCE

Presented annually to an outstanding student in the Space Systems Operations program in recognition of distinguished academic achievement based upon grades obtained, quality of thesis and overall performance.

WARREN RANDOLPH CHURCH AWARD

Presented annually to an officer student for outstanding performance in mathematics. The criteria for selection include evidence of initiative, scholarly attitude and mathematical maturity.

APPENDIX C: AWARDS FOR FACULTY

THE CARL E. AND JESSIE W. MENNEKEN AWARD FOR EXCELLENCE IN SCIENTIFIC RESEARCH

This monetary award is presented annually to a junior NPS faculty member in recognition of meritorious research which has significant identifiable impact on military technology. Funding for the award has been provided to the NPS Foundation by Mrs. Jessie W. Menneken. Presented at the December graduation if suitable candidates are nominated.

EARL E. MENNEKEN RESEARCH AWARD

Awarded at the Spring initiation meeting of Sigma Xi and acknowledged at the June commencement exercises, this award is based on distinguished research contributions.

DISTINGUISHED PROFESSOR AWARD

Presented to a faculty member who has merited recognition for his or her scholarly accomplishments and lasting educational contributions to the school. The recipient of this award joins a select group of faculty bearing the title of Distinguished Professor.

EAR ADMIRAL JOHN JAY SCHIEFFELIN AWARD FOR EXCELLENCE IN TEACHING

This monetary award is presented annually, at the June graduation, to recognize a faculty member who, through wide consensus, excels as a teacher. The consensus is ascertained through a ballot polling of current students and graduates. Funding for the award was provided to the NPS Foundation by a gift from Mr. William J. Schieffelin.

INDEX

| | |
|--|---------|
| Academic Calendar | 353-354 |
| Academic Counseling | 23 |
| Academic Departments and Groups | |
| Listing | 13 |
| Aeronautics and Astronautics Department | 161 |
| Faculty | 161-162 |
| Master of Science in Aeronautical Engineering | |
| Requirements | 162 |
| Master of Science in Engineering Science Requirements | 163 |
| Master of Science in Astronautical Engineering | |
| (Curriculum 591) Requirements | 163 |
| Aeronautical and Astronautical Engineer Requirements | 163 |
| Doctor of Philosophy in Aeronautical Engineering | |
| Requirements | 164 |
| Doctor of Engineering in Aeronautical Engineering | |
| Requirements | 164 |
| Aeronautical Laboratories | 164-166 |
| Spacecraft Laboratories | 166 |
| Navy-NASA Joint Institute of Aeronautics | 166 |
| Course Offerings | 166-176 |
| Aviation Safety Programs | 177 |
| Faculty | 177 |
| Aviation Safety Officer Course | 177-178 |
| Aviation Safety Command Course | 178 |
| Course Offerings | 178-179 |
| Command, Control and Communications (C3) | |
| Academic Group | 180 |
| Faculty | 180 |
| Master of Science in Systems Technology Requirements | 181 |
| Course Offerings | 181-182 |
| Computer Science Department | 183 |
| Faculty | 183-184 |
| Master of Science in Computer Science Requirements | 184-185 |
| Doctor of Philosophy in Computer Science Requirements | 185 |
| Computer Science Laboratories | 185-186 |
| Course Offerings | 186-194 |
| Electrical and Computer Engineering Department | 195 |
| Faculty | 195-197 |
| Master of Science in Electrical Engineering Requirements | 197-198 |
| Master of Science in Engineering Science Requirements | 198 |
| Electrical Engineer Requirements | 198 |
| Doctor of Philosophy in Electrical and Computer | |
| Engineering Requirements | 198 |
| Electrical and Computer Engineering Laboratories | 198-199 |
| Course Offerings | 199-216 |
| Electronic Warfare Academic Group | 217 |
| Faculty | 217 |
| Master of Science in Systems Engineering Requirements | 217 |
| Course Offerings | 218 |
| Engineering Acoustics Academic Committee | 219 |
| Master of Science in Engineering Acoustics Requirements | 219 |
| Doctor of Philosophy in Engineering Acoustics | |
| Requirements | 219 |
| Doctor of Engineering in Engineering Acoustics | |
| Requirements | 219 |

| | |
|---|---------|
| Mathematics Department | 220 |
| Faculty | 220-221 |
| Master of Science in Applied Mathematics Requirements | 221 |
| Doctor of Philosophy in Applied Mathematics | 222 |
| Course Sequence for Special Curricula | 222 |
| Course Offerings | 222-231 |
| Mechanical Engineering Department | 232 |
| Faculty | 232-233 |
| Master of Science in Mechanical Engineering Requirements | 233 |
| Master of Science in Engineering Science Requirements | 234 |
| Mechanical Engineer Requirements | 234 |
| Doctor of Philosophy in Mechanical Engineering Requirements | 234-235 |
| Doctor of Engineering in Mechanical Engineering Requirements | 234-235 |
| Mechanical Engineering Laboratories | 235 |
| Course Offerings | 235-243 |
| Meteorology Department | 244 |
| Faculty | 244-245 |
| Master of Science in Meteorology Requirements | 245 |
| Master of Science in Meteorology and Physical Oceanography Requirements | 246 |
| Doctor of Philosophy in Meteorology Requirements | 246 |
| Meteorology Laboratories | 246-247 |
| Course Offerings | 247-252 |
| National Security Affairs Department | 253 |
| Faculty | 253-254 |
| Master of Arts in National Security Affairs Requirements | 255 |
| Master of Science in National Security Affairs Requirements | 255-256 |
| Professional Military Education (PME), and Joint Professional Military Education (JPME) Equivalence | 256 |
| Course Offerings | 256-267 |
| Oceanography Department | 268 |
| Faculty | 268-269 |
| Master of Science in Physical Oceanography Requirements | 269-270 |
| Master of Science in Meteorology and Physical Oceanography Requirements | 270 |
| Doctor of Philosophy in Oceanography Requirements | 270 |
| Oceanographic Laboratories | 270-271 |
| Course Offerings | 271-275 |
| Operations Research Department | 276 |
| Faculty | 276-278 |
| Master of Science in Applied Science Requirements | 278 |
| Master of Science in Operations Research Requirements | 278-279 |
| Doctor of Philosophy in Operations Research Requirements | 279 |
| Course Offerings | 279-291 |
| Physics Department | 292 |
| Faculty | 292-293 |
| Master of Science in Physics Requirements | 293 |
| Master of Science in Applied Physics | 294 |
| Doctor of Philosophy in Physics Requirements | 294 |
| Physics Laboratories | 294-295 |
| Course Offerings | 295-309 |

| | |
|--|--------------|
| Space Systems Academic Group | 310 |
| Group Facilities | 310 |
| Course Offerings | 310-311 |
| Systems Management Department | 312 |
| Faculty | 312-315 |
| Master of Science in Information Technology | |
| Management Requirements | 316 |
| Master of Science in Management Requirements | 316 |
| Master of Science in International Resource Planning, and | |
| Management Requirements | 316-317 |
| Doctor of Philosophy in Systems Management | 317 |
| Course Offerings | 317-332 |
| Undersea Warfare Academic Group | 333 |
| Faculty | 333 |
| Master of Science in Applied Science Requirements | 333 |
| Course Offerings | 334 |
| Academic Profile Codes | 20-21 |
| Accreditation | 7 |
| Administration | 12 |
| Administrative Staff | 12 |
| Aeronautical and Astronautical Engineer Requirements | 163 |
| Aeronautical Laboratories | 164-166 |
| Aeronautics and Astronautics Department | 161-176 |
| Aerospace Engineering Programs | 29-37 |
| Aviation Safety Programs | 177-179 |
| Aviation Safety Command Course | 178 |
| Aviation Safety Officer Course | 177-178 |
| Awards for Graduates | 341-344 |
| Awards for Faculty | 345 |
| Board of Advisors | 11 |
| Campus Computing | 9-10 |
| Catalogs, Ordering Information | Inside Cover |
| Chief of Naval Operations Statement | 6 |
| Civilian Universities | 27 |
| Combat Systems Programs | 48-52 |
| Command, Control and Communications (C3) | |
| Academic Group | 180-182 |
| Computer Science Department | 183-194 |
| Computer Science Laboratories | 185-186 |
| Course Codes | 22 |
| Course Overload | 24 |
| Course Registration and Credit | 24 |
| Overload | 24 |
| Repetition of Courses | 24 |
| Medical Absence | 24 |
| Credit by Examination | 24 |
| Curricula Summary | 15-18 |
| Curriculum 360, Operations Analysis | 97-98 |
| Curriculum 361, Operational Logistics | 98-100 |
| Curriculum 365, Joint Command, Control | |
| and Communications (C3) | 62-65 |
| Curriculum 366, Space Systems Operations | 146-147 |
| Curriculum 368, Computer Science | 53-55 |
| Curriculum 370, Information Technology Management | 107 |
| Curriculum 372, Meteorology | 38-39 |
| Curriculum 373, METOC | 39-41 |
| Curriculum 374, Operational Oceanography | 41-43 |

| | |
|---|----------------|
| Curriculum 380, Advanced Science (Applied Mathematics) | 100-101 |
| Curriculum 440, Oceanography | 43-45 |
| Curriculum 525, Undersea Warfare | 147-149 |
| Curriculum 533, Combat Systems Sciences And Technology | 48-52 |
| Curriculum 570, Naval/Mechanical Engineering Programs | 91-96 |
| Curriculum 590, Electronic Systems Engineering | 55-57 |
| Curriculum 591, Space Systems Engineering | 150-151 |
| Curriculum 595, Electronic Warfare | 151-153 |
| Curriculum 596, Electronic Warfare (International) | 153-154 |
| Curricula 610 and 611, Aeronautical Engineering and Aeronautical Engineering with Avionics | 29-32 |
| Curricula 681 - 684, Area Studies | 66-70 |
| Curriculum 688, Strategic Planning and International Organizations and Negotiations | 70-72 |
| Curriculum 699, Special Operations/Low Intensity | 72-73 |
| Curriculum 813, Transportation Logistics Management | 109-110 |
| Curriculum 814, Transportation Management | 111-112 |
| Curriculum 815, Acquisition and Contract Management | 112-114 |
| Curriculum 816, Systems Acquisition Management | 114-118 |
| Curriculum 817, Systems Management | 118-120 |
| Curriculum 818, Defense Systems Management | 120-122 |
| Curriculum 819, Systems Inventory Management | 122-124 |
| Curriculum 820, Resource Planning and Management for International Defense | 73-75, 124-125 |
| Curriculum 825, Intelligence | 75-77 |
| Curriculum 827, Material Logistics Support Management | 125-127 |
| Curriculum 837, Financial Management | 127-129 |
| Curriculum 847, Manpower, Personnel and Training Analysis | 129-131 |
| Curricular Offices Description, listing | 13 |
| Aerospace Engineering Programs | |
| Aeronautical Engineering and Aeronautical Engineering with Avionics, Curricula 610 and 611 | 29-37 |
| Meteorology and Oceanography Programs | 38-47 |
| Meteorology, Curriculum 372 | 38-39 |
| METOC, Curriculum 373 | 39-41 |
| Operational Oceanography, Curriculum 374 | 41-43 |
| Oceanography, Curriculum 440 | 43-45 |
| Combat Systems Programs | 48-52 |
| Combat Systems Sciences and Technology, Curriculum 533 | 48-52 |
| Electronics and Computer Programs | 53-61 |
| Computer Science, Curriculum 368 | 53-55 |
| Electronic Systems Engineering, Curriculum 590 | 55-57 |
| Joint Command, Control and Communications (C3), Curriculum 365 | 62-65 |
| National Security Affairs and Intelligence Programs | 66-90 |
| Area Studies, Curricula 681 - 684 | 66-70 |
| Strategic Planning and International Organizations and Negotiations, Curriculum 688 | 70-72 |
| Special Operations/Low Intensity, Curriculum 699 | 72-73 |
| Resource Planning and Management for International Defense, Curriculum 820 | 73-75 |
| Intelligence, Curriculum 825 | 75-77 |
| Naval/Mechanical Engineering Programs | 91-96 |
| Naval/Mechanical Engineering Programs, Curriculum 570 | 91-96 |
| Operations Research Programs | 97-106 |
| Operations Analysis, Curriculum 360 | 97-98 |

| | |
|---|---------|
| Operational Logistics, Curriculum 361 | 98-100 |
| Advanced Science (Applied Mathematics), Curriculum 380 | 100-101 |
| Systems Management Programs | 107-145 |
| Information Technology Management, Curriculum 370 | 107-109 |
| Transportation Logistics Management, Curriculum 813 | 109-110 |
| Transportation Management, Curriculum 814 | 111-112 |
| Acquisition and Contract Management, Curriculum 815 | 112-114 |
| Systems Acquisition Management Curriculum 816 | 114-118 |
| Systems Management, Curriculum 817 | 118-120 |
| Defense Systems Management, Curriculum 818 | 120-122 |
| Systems Inventory Management, Curriculum 819 | 122-124 |
| Resource Planning and Management for International Defense, Curriculum 820 | 124-125 |
| Material Logistics Support Management, Curriculum 827 | 125-127 |
| Financial Management, Curriculum 837 | 127-129 |
| Manpower, Personnel and Training Analysis, Curriculum 847 | 129-131 |
| Undersea Warfare, Space Systems, and Electronic Warfare Programs | 146-160 |
| Space Systems Operations, Curriculum 366 | 146-147 |
| Undersea Warfare, Curriculum 525 | 147-149 |
| Space Systems Engineering, Curriculum 591 | 150-151 |
| Electronic Warfare, Curriculum 595 | 151-153 |
| Electronic Warfare (International), Curriculum 596 | 153-154 |
| Defense Resources Management Institute | 335 |
| Faculty | 335 |
| Defense Resources Management Course | 336-337 |
| International Defense Management Course | 337 |
| Senior International Defense Management Course | 337 |
| Defense Resources Management Institute Fiscal Year Schedule | 338 |
| Degree Programs, Civilian Students | 20 |
| Degrees Conferred | 7-8 |
| Distinguished Alumni | 339 |
| Doctor of Engineering in Aeronautical Engineering Requirements | 164 |
| Doctor of Engineering in Engineering Acoustics Requirements | 219 |
| Doctor of Engineering in Mechanical Engineering Requirements | 234-235 |
| Doctor of Philosophy in Systems Management Requirements | 317 |
| Doctor of Philosophy in Applied Mathematics Requirements | 222 |
| Doctor of Philosophy in Aeronautical Engineering Requirements | 164 |
| Doctor of Philosophy in Computer Science Requirements | 185 |
| Doctor of Philosophy in Electrical and Computer Engineering Requirements | 198 |
| Doctor of Philosophy in Engineering Acoustics Requirements | 219 |
| Doctor of Philosophy in Mechanical Engineering Requirements | 234-235 |
| Doctor of Philosophy in Meteorology Requirements | 246 |
| Doctor of Philosophy in Oceanography Requirements | 270 |
| Doctor of Philosophy in Physics Requirements | 294 |
| Doctor of Philosophy in Operations Research | 279 |
| Dual Degree Programs | 25 |
| Dudley Knox Library | 9 |
| Electrical and Computer Engineering Department | 195-216 |

| | |
|---|---------|
| Electrical and Computer Engineering Laboratories..... | 198-199 |
| Electrical Engineer Requirement | 198 |
| Electronics and Communications Programs | 53-61 |
| Electronic Warfare Academic Group | 217-218 |
| Engineering Acoustics Academic Committee | 219 |
| Educational Skill Requirements | 25-26 |
| Faculty Organizations | 18 |
| Grading | 22-23 |
| Graduate Education Review Board | 11 |
| International Programs Office..... | 14 |
| Joint Command, Control and Communications (C3) Programs | 62-65 |
| Master of Arts in National Security Affairs Requirements | 255 |
| Master of Science in Aeronautical Engineering Requirements | 162 |
| Master of Science in Applied Mathematics Requirements | 221 |
| Master of Science in Applied Science Requirements | 278,333 |
| Master of Science in Astronautical Engineering (Curriculum 591) Requirements | 163 |
| Master of Science in Computer Science Requirements | 184-185 |
| Master of Science in Electrical Engineering Requirements | 197-198 |
| Master of Science in Engineering Science Requirements | 198 |
| Master of Science in Management Requirements | 316 |
| Master of Science in Mechanical Engineering Requirements | 233 |
| Master of Science in Meteorology Requirements | 245 |
| Master of Science in Meteorology and Physical Oceanography Requirements | 270 |
| Master of Science in National Security Affairs Requirements | 255-256 |
| Master of Science in Operations Research Requirements | 278-279 |
| Master of Science in Physical Oceanography Requirements | 269-270 |
| Master of Science in Physics Requirements | 293 |
| Master of Science in Systems Engineering Requirements | 217 |
| Master of Science in Systems Technology Requirements | 181 |
| Mathematics Department | 220-231 |
| Mechanical Engineer Requirements | 234 |
| Mechanical Engineering Department..... | 232-243 |
| Mechanical Engineering Laboratories | 235 |
| Medical Absence | 24 |
| Meteorology and Oceanography (METOC) Programs | 38-47 |
| Meteorology Department | 244-252 |
| Meteorology Laboratories | 246-247 |
| The Mission of NPS | 7 |
| Quality Point Rating, (QPR) | 23 |
| National Security Affairs Department | 253-267 |
| National Security and Intelligence Programs | 66-90 |
| Naval/Mechanical Engineering Programs | 91-96 |
| Naval Postgraduate School Alumni Association | 11 |
| Naval Postgraduate School, Introduction | 6 |
| Naval Postgraduate School Foundation | 10 |
| Navy-NASA Joint Institute of Aeronautics | 166 |
| Non-Degree Programs, Civilian Students | 20 |
| Oceanographic Laboratories | 270-271 |
| Oceanography Department..... | 268-275 |
| Operations Research Department | 276-291 |
| Operations Research Programs | 97-106 |

| | |
|--|---------|
| Physics Department | 292-309 |
| Physics Laboratories | 294-295 |
| Regular Curricula, Civilian Students | 20 |
| Repetition of Courses | 24 |
| The School | 7 |
| Selection Procedures | 19 |
| Naval Officers | 19 |
| Other U.S. Military | 19 |
| International Military Officers | 19 |
| Civilian Employees of U.S. Government | 19 |
| Regular Curricula | 20 |
| Degree Programs | 20 |
| Non-Degree Programs | 20 |
| Admission | 20 |
| Space Systems Academic Group | 310-311 |
| Student Council | 18 |
| Systems Management Department | 312-332 |
| Systems Management Programs | 107-145 |
| Transfer of Credits | 24-25 |
| Undersea Warfare Academic Group | 333-334 |
| Undersea Warfare, Space Systems, and Electronic Warfare Programs | 146-160 |
| Validation | 24 |

ACADEMIC CALENDAR AY 1995

FALL QUARTER

| | |
|------------------------------|----------------------------|
| Reporting Date | Monday September 19, 1994 |
| Instruction Begins | Monday September 26, 1994 |
| Columbus Day (Holiday) | Monday October 10, 1994 |
| Reporting Date for Refresher | Monday October 31, 1994 |
| Refresher Begins | Monday November 7, 1994 |
| Veteran's Day (Holiday) | Friday November 11, 1994 |
| Thanksgiving Day (Holiday) | Thursday November 24, 1994 |
| Final Examination Begin | Monday December 12, 1994 |
| Graduation | Thursday December 15, 1994 |
| Christmas Break | 16 Dec - 2 Jan 1995 |

WINTER QUARTER

| | |
|---|--------------------------|
| Reporting Date | Monday January 3, 1995 |
| Instruction Begins | Tuesday January 4, 1995 |
| Martin Luther King's Birthday (Holiday) | Monday January 16, 1995 |
| Reporting Date for Refresher | Monday February 6, 1995 |
| Refresher Begins | Monday February 13, 1995 |
| George Washington's Birthday (Holiday) | Monday February 20, 1995 |
| Final Examinations Begin | Monday March 20, 1995 |
| Graduation | Thursday March 23, 1995 |

SPRING QUARTER

| | |
|------------------------------|------------------------|
| Reporting Date | Monday March 20, 1995 |
| Instruction Begins | Monday March 27, 1995 |
| Reporting Date for Refresher | Monday May 1, 1995 |
| Refresher Begins | Monday May 8, 1995 |
| Memorial Day (Holiday) | Monday May 29, 1995 |
| Final Examination Begin | Monday June 12, 1995 |
| Graduation | Thursday June 15, 1995 |
| Summer Break | 16 Jun. - 30 Jun. 1995 |

SUMMER QUARTER

| | |
|------------------------------|-----------------------------|
| Reporting Date | Monday June 26, 1995 |
| Instruction Begins | Monday July 3, 1995 |
| Independence Day (Holiday) | Tuesday July 4, 1995 |
| Reporting Date for Refresher | Monday August 7, 1995 |
| Refresher Begins | Monday August 14, 1995 |
| Labor Day (Holiday) | Monday September 4, 1995 |
| Final Examinations Begin | Monday September 18, 1995 |
| Graduation | Thursday September 21, 1995 |

ACADEMIC CALENDAR AY 1996

FALL QUARTER

| | |
|------------------------------|-----------------------------|
| Reporting Date | Monday, September 18, 1995 |
| Instruction Begins | Monday, September 25, 1995 |
| Columbus Day (Holiday) | Monday, October 9, 1995 |
| Reporting Date for Refresher | Monday, October 30, 1995 |
| Refresher Begins | Monday, November 6, 1995 |
| Veteran's Day (Holiday) | Friday, November 10, 1995 |
| Thanksgiving Day (Holiday) | Thursday, November 23, 1995 |
| Final Examinations Begin | Monday, December 11, 1995 |
| Graduation | Thursday, December 14, 1995 |
| Christmas Break | 15 Dec. - 5 Jan. 1996 |

WINTER QUARTER

| | |
|---|----------------------------|
| Reporting Date | Tuesday, January 4, 1996 |
| Instruction Begins | Wednesday January 8, 1996 |
| Martin Luther King's Birthday (Holiday) | Monday, January 15, 1996 |
| Reporting Date for Refresher | Monday, February 12, 1996 |
| Washington's Birthday (Holiday) | Monday, February 19, 1996 |
| Refresher Begins | Tuesday, February 20, 1996 |
| Final Examinations Begin | Monday, March 25, 1996 |
| Graduation | Thursday, March 28, 1996 |

SPRING QUARTER

| | |
|------------------------------|-------------------------|
| Reporting Date | Monday, March 25, 1996 |
| Instruction Begins | Monday, April 1, 1996 |
| Reporting Date for Refresher | Monday, May 6, 1996 |
| Refresher Begins | Monday, May 13, 1996 |
| Memorial Day (Holiday) | Monday, May 27, 1996 |
| Final Examinations Begin | Monday, June 17, 1996 |
| Graduation | Thursday, June 20, 1996 |
| Summer Break | 21 June - 5 Jul 1996 |

SUMMER QUARTER

| | |
|------------------------------|------------------------------|
| Reporting Date | Monday, July 1, 1996 |
| Independence Day (Holiday) | Thursday, July 4, 1996 |
| Instruction Begins | Monday, July 8, 1996 |
| Reporting Date for Refresher | Monday, August 12, 1996 |
| Refresher Begins | Monday, August 19, 1996 |
| Labor Day (Holiday) | Monday, September 2, 1996 |
| Final Examinations Begin | Monday, September 23, 1996 |
| Graduation | Thursday, September 26, 1996 |



NAVAL POSTGRADUATE SCHOOL

MONTEREY, CALIFORNIA 93943-5134
408/656-3093 DSN 878-3093